THE GLASS INDUSTRY

VOLUME 34, NUMBER 11, NOVEMBER, 1953

ELECTRIC ANNEALING AND AUXILIARY HEATING IN THE GLASS INDUSTRY

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TRANSLATED BY S. R. SCHOLES

PART I

The author has already reported in this Journal[1] on the development of electrically-heated melting furnaces for glass manufacture. However, while these electric furnaces are only slowly becoming established in factories, electric lehrs and auxiliary furnaces have been in operation for a long time and with great success. Today, the electric lehr is regarded as one of the most helpful aids to glass production available for the attainment of a truly precise and therefore scientific annealing of formed glasswares. Its superiority over gas-fired lehrs rests upon the fully automatic, relatively simple regulation of temperature peculiar to electrical heating. This permits the establishment of any necessary or desirable course of temperature change, according to a strict annealing curve, which can safely and automatically be followed by the lehr. Because of this possibility of realizing the theoretically needed and best cooling curve, loss and breakage can be reduced to a fraction of one per cent, which is a goal unattainable with gas firing. This desired end can be reached only when annealing follows the optimum cooling curve established by theory and then tested. Only in this case profit is earned by using the electric current—an expensive form of energy—not by building cheaper electric lehrs, but by employing scientific methods. On account of the great importance which the theory of annealing has in particular for electric lehrs, this subject will be discussed closely in what follows.

The Theory of Annealing; Origin of Strains in Glass

The internal structure of glass is characterized by the extraordinarily rapid increase in viscosity which occurs when the glass cools from the fluid state of aggregation.

In order for crystal nuclei to form and for complete crystals to grow, as in metals and salt solutions, the molecules must have a certain freedom of movement during the freezing process. In glasses, viscosity increases so swiftly in the vicinity of the "freezing point" that crystallization is hindered. The change from liquid to solid condition occurs, not at a fixed characteristic temperature as in the melting and crystallization of the metals, but glass becomes stiffer and stiffer up to complete solidification without reference to any particular definite point of temperature. This behavior is the same as that of an undercooled liquid.

Viscosity is of tremendous importance in the industrial production of glass; upon it depend the temperatures of gathering, forming and annealing, also the speed of working. The viscosity of glasses in the annealing ranges is practically constant. Its mean value is: $\eta = 5.6 \times 10^{13}$, corresponding to log viscosity 13.75.

If a fluid homogeneous glass body, for example a ball, which has the same temperature throughout and is quite strain-free, is cooled, there arises a temperature gradient between outside and inside portions. The exterior tends to contract more strongly than the interior because it cools more quickly. So long as the temperature does not fall below the annealing range, the differences in density tend to equalize by molecular movement. Next, a leather-hard skin forms on the outside of the ball which hardens to a solid crust when the transformation point is reached. This hide encloses an interior mass which has still a temperature gradient toward the exterior, but is at the same time more or less strain-free. As the interior also becomes solid as a result of further cooling, it contracts more strongly than the already solid outer crust. Thus arises strains, which are the less able to equalize themselves, the more rapid the cooling. The previously strain-free glass body possesses strains thus originating, accord-

Fig. 1. The origin of strains in a cooling glass body. a = exterior shell; b = core; 1 = first phase: shell cooling; 2 = second phase: core cooling; 3 = third phase: final condition.

ing to the relative temperature experienced, *permanent strains*. As shown in Fig. 1, the spherical body is now in radial tension. Its interior is in tangential tension and its exterior in tangential compression. In between, a neutral zone exists.

In contrast to these "permanent" strains, only *"temporary"* strains are introduced by cooling or heating a glass body at temperatures *below* the annealing range. These temporary strains disappear as soon as the glass body in its entirety again acquires a uniform temperature.

* An apparent reversal, the result of the soft glass specimen's yielding in the apparatus used. S.R.S.

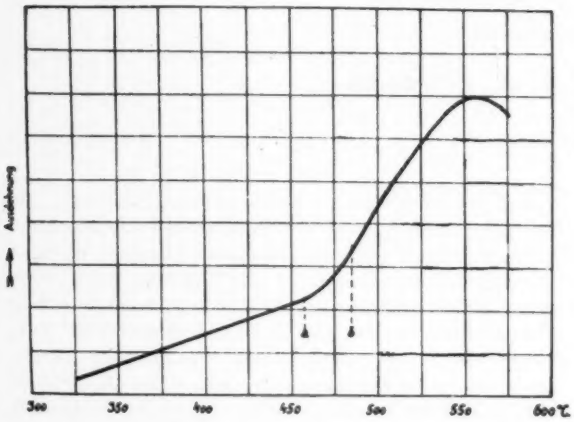

Fig. 2. Characteristic course of expansion of glass in relation to temperature. a — b = Region where softening begins.

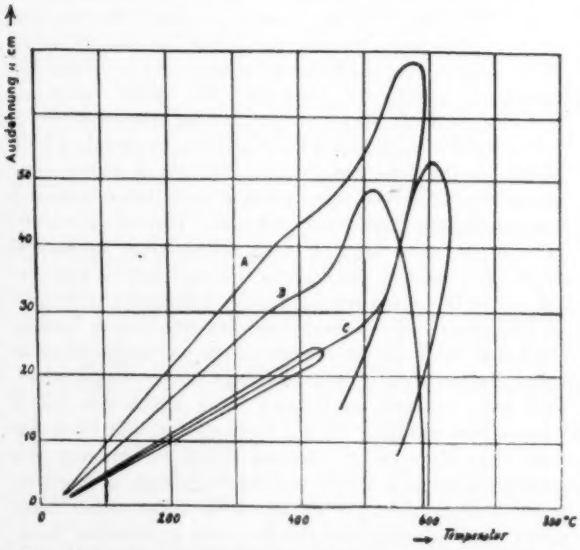

Fig. 3. Expansion curves for different glasses. A = Soda glass; B = Lead glass; C = Apparatus glass.

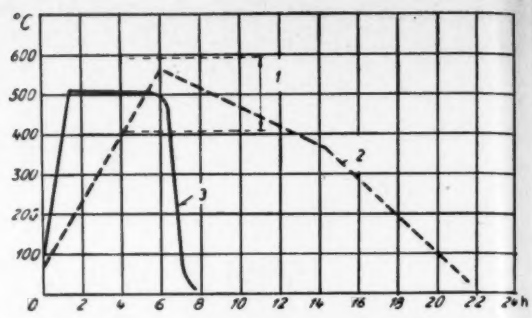

Fig. 4. Comparison of the older, defective annealing method with the modern rapid annealing process. 1 = Critical region; 2 = Older method; 3 = Modern process.

Thermal Expansion

The characteristic course of expansion in relation to temperature is shown by Fig. 2. This is regular and linear up to the region where softening begins. From there on (temperature range a-b, in Fig. 2), the expansion increases rapidly up to a maximum value, then falls off suddenly*. Fig. 3 shows expansions for three different kinds of glass (after Peters and Cragoe).

Strain Point

By strain point is meant that temperature at which (for strained glass) the expansion curve shows an inflection from its regular course (cf. Figs. 2 and 3). It corresponds with the lowest temperature at which strain release can be optically observed by the lessening of birefringence. It lies about 100°C. below the transformation point. In practical annealing, the strain point is the lowest temperature at which annealing is still possible in finite time.

Modern Annealing Procedure

The object of thermal after-treatment of glass in the lehr is the attainment of the most nearly strain-free condition possible in the glassware. To reach this goal, two extremes of method will be described,[2, 3] between which the rapid annealing procedure lies which will produce correct annealing in the shortest time possible.

In the older procedure, the glass to be annealed was brought to a temperature near its softening point where strains instantly disappeared. However, this required exceedingly slow cooling in order to prevent high temperature gradients in the glass.

In the more recent procedure (cf. Fig. 4), the glass is allowed to lose its strain at a temperature only slightly above its strain point (lower limit of annealing range). The glass can then relatively quickly be brought below its strain point where, at a few degrees lower, the molecules are fixed in position. Below the strain point, cooling may proceed as fast as the article will stand the temporary strains without breaking, since these temporary strains will disappear upon complete cooling.

"Temporary" Strain and Thermal Endurance

It is a well-known fact that glass articles are more or less sensitive to sudden changes of temperature and may

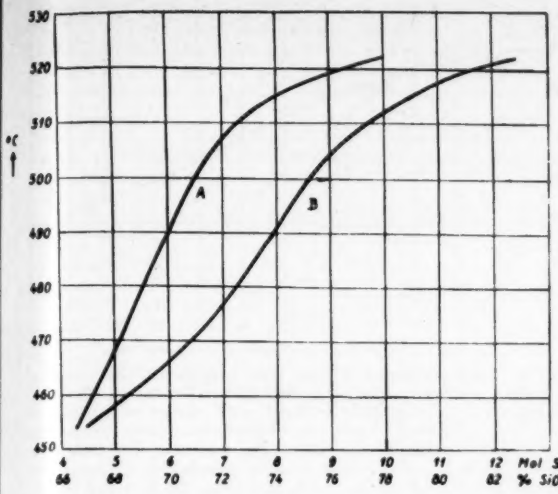

Fig. 5. Influence of silica (SiO_2) on the upper annealing temperatures of soda-silica glasses (after English, Hodkin, Muirhead, and Turner). Curve A is based on Mols SiO_2; curve B, on % SiO_2.

be cracked in that way. These breaks are caused by temporary strains. The relative ability of a glass to withstand sudden temperature changes is called its thermal endurance, and it depends principally upon coefficient of linear expansion. The lower this coefficient, the greater the thermal endurance is. The relationship between these two values is easily understood from the following: If a slab of glass of length l is heated throughout to a temperature O_1 C., and one side of the slab is then suddenly cooled to O_0, the temperature difference amounts to

$$\Delta T = (O_1 - O_0)\ ^\circ C.$$

To this temperature difference corresponds a length difference of

$$\Delta l = \beta_l \,.\, l \,.\, \Delta T.$$

The two sides being firmly bound together, and the elastic moduli of glasses for stretching and for compression being nearly equal, equally distributed forces can be assumed. One side will be extended by $\frac{\Delta l}{2}$, and the other side equally shortened. From the elastic modulus and the stretching and shortening, the corresponding forces can be estimated:

$$P_t = P_c = \frac{\Delta l}{2l} \,.\, E = \frac{E}{2} \,.\, \beta_l \,.\, \Delta T_2$$

in which P_t = tension in Kg./mm.², P_c = compression in Kg/mm.², βl = coefficient of linear expansion, and E = modulus of elasticity.

The tensile strength of glass is always less than its compressive strength, and so the slab will always tend to break on its tensed (cooler) side. Since sudden cooling develops superficial tension and sudden heating develops compression, glass is necessarily more sensitive to cooling than to heating shock.

For a sphere, H. Hoverstadt sets out the following formula:

$$\Delta T\ (max.) = O_1 - O_0 = (1 - \sigma)\ \frac{F_t}{\beta l\, E}\ *$$

This formula gives the maximum endurable temperature differences between surface and center of the glass ball. In it, σ means Poisson's ratio.

The modulus of elasticity for glass ranges, according to composition, from 5500 to 8000 Kg/mm.², and the value of Poisson's ratio σ is 0.18 — 0.27, in general 0.22 — 0.23. The tensile strength of glasses varies between 4.0 and 8.5 Kg./mm.² (normally about 6 to 8 Kg./mm.²).

Strains in glass bodies in the rigid state caused by temperature differences disappear as soon as the expansion differences between the different glass layers disappear as temperature equalizes. Uniformity of temperature results from conduction. On account of the low conductivity of glass—specifically, the coefficient is only about 0.002—this uniformity is only slowly reached. Therefore, if a glass object is to be cooled some point below the strain point to room temperature, attention must be paid not only to the thermal endurance of the glass, but also to heat conduction in the particular glass body. The form of the object, the thickness of its walls and other factors are important.

Annealing Temperatures

We distinguish between upper and lower annealing temperatures, the latter corresponding closely to strain point. By upper annealing temperature is understood the temperature at which glass loses its strain very rapidly, without beginning to deform. At the lower annealing temperature, the strains can scarcely be made to disappear.

Numerous researches have dealt with the dependence of annealing temperatures upon the composition of glasses. Here, these involved relationships will not be closely discussed. Figs. 5 to 7 show the effects of specific oxides, as reported by Gehlhoff and Thomas. It must be remarked that a somewhat confusing lack of agreement on data appears in reports from separate observers. Closer study shows, however, that the various observations and numbers agree by and large. Differences may well be laid to the varieties of research methods employed.

Calculation of Cooling Speed

In the descending branch of the cooling curve, two different cooling speeds are to be distinguished (see Figs. 8, 9 and 10): (a) Slow cooling from the temperature at which the glass has been held for a time, until the

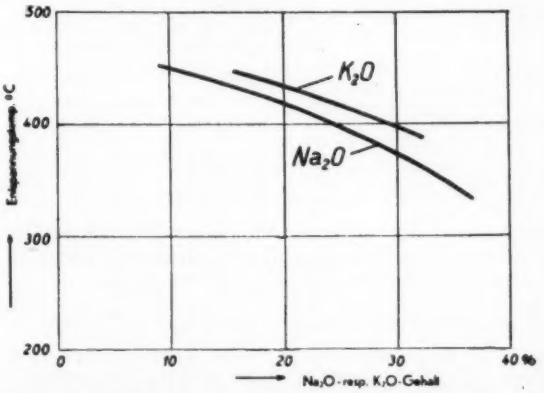

Fig. 6. Influence of alkalis on strain point (after Thomas and Gehlhoff and Thomas). Glass composition: 80% (SiO_2 + Alk.), 20% PbO.

* Incorrectly printed in the original paper. S.R.S.

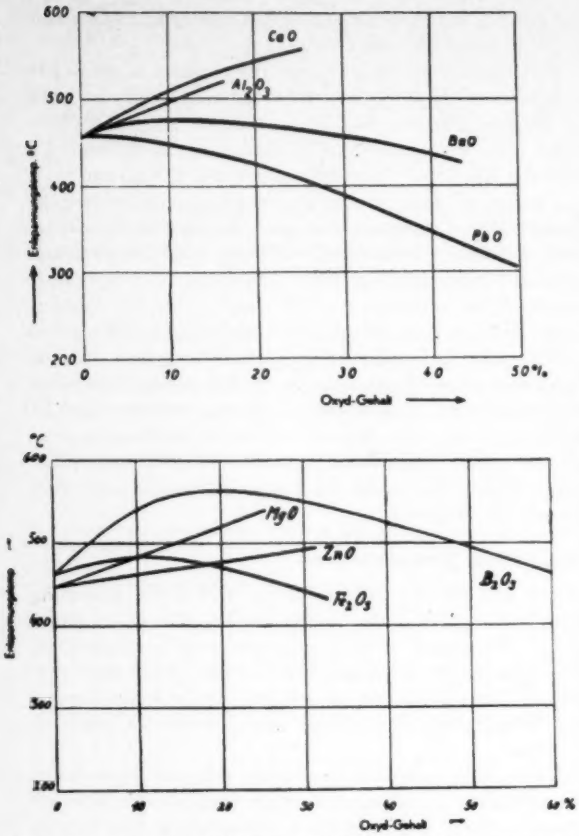

Fig. 7, a and b. Influence of different oxides on strain point (after Thomas). Glass composition: 82% (SiO_2 + oxide), 18% Na_2O.

greater part of the strain has disappeared, to a point below the strain point where the glass molecules are fixed in position. For the calculation of the slow cooling to a temperature below the strain point, and for the rate that determines the residual strain that can be permitted, Adams and Williamson have given the following formula:

$$h_1 = \frac{-12.10^4 \cdot Pp \cdot \lambda \cdot (1-\sigma}{3600 \cdot Cp \cdot g \cdot E \cdot \beta_1 \cdot S^2} = {}^\circ\text{C. per second.}$$

In which:

h_1 = cooling speed for the range specified;
Pp = permissible residual strain in kg./cm².;
λ = conductivity in K-cal./m./hr./C.;
σ = Poisson's ratio;
C_P = Specific heat in K-cal./g/C.
g = density in kg./m.³;
E = modulus of elasticity;
β_1 = coefficient of linear expansion;
S = thickness of glass (wall) in cm.

In practice, the true values for the glass to be annealed are not known. In most instances, the following examples may find application in operating the formula:

Permissible Residual Strain. According to Twyman, it suffices for good annealing of ordinary commercial ware if only 5% of the breaking stress of the glass remains; that is, if the glass has a breaking stress of 600 to 800 Kg./cm,² the permissible residual stress is 30 to 40 Kg./cm². In optical glass, the residual stress should be less

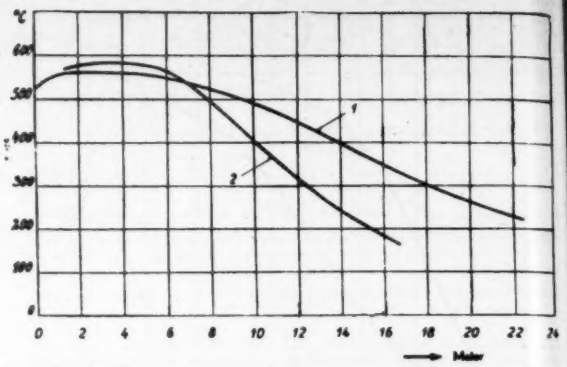

Fig. 8. Measurements of the true course of the cooling curve in an electric lehr with conveyor belt; traveling thermocouples are placed in contact with ware; temperature plotted vs. distance. Curve 1. Taken in a lehr annealing beer bottles weighing 14 oz. each, traveling 50 feet per hour. Curve 2. Taken in a lehr annealing Pyrex-glass mayonnaise glasses, 8 oz. each, traveling 20 feet per hour.

than 1% of the breaking stress, or less than 8 kg./cm².

Conductivity. Conductivity is difficult to measure by experiment. If the composition of the glass is known, the factors developed by Winkelmann or Russ can be used to estimate conductivity. It is to be noted that the conductivity increases with rising temperature. (A table of conductivities for a number of glasses is not repeated here.) The values at 100°C. range from 0.65 for heavy flint glass to 1.0 for borosilicates and 1.64 for fused quartz; all in K-cal./m./hr./°C./m²area.

Poisson's Ratio. Poisson's Ratio, σ, expressing the quotient of crosswise contraction to lengthwise stretching, has a mean value of 0.22 to 0.23.

Specific Heat. This value can be calculated from factors supplied by Winkelmann. At room temperature, it has a mean value of 0.2 for ordinary glasses.

Density. Values of density range from 2100 to 6300 kg./m.³ They may be safely calculated from composition. Some values are given:

Plate glass	2500
Apparatus glass	2270
Themometer glass	2390
Optical glass	2230-6670

Modulus of Elasticity. The modulus of elasticity for

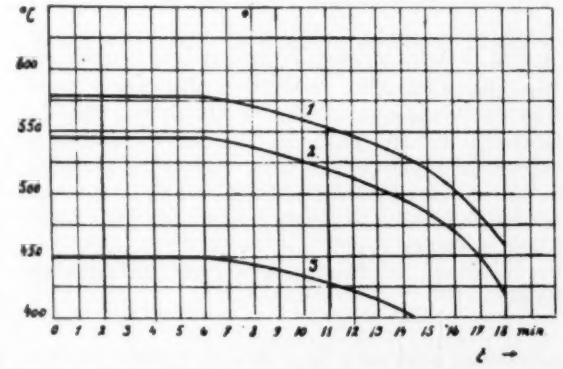

Fig. 9. Cooling curves for mouth-blown bottles, wall thickness, 3 mm. 1, 2, 3: Glasses with high, medium and low annealing and softening points.

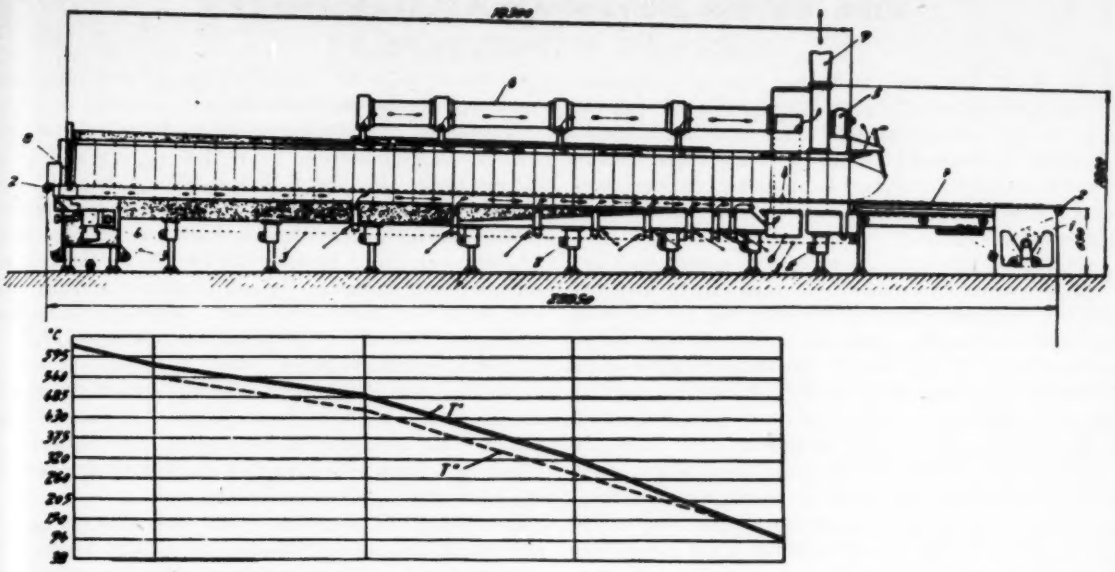

Fig. 10. **Principal details of the Hartford lehr (oil-fired) and temperature curve in the lehr. T′ = Temperature at top of lehr canal. T″ = Temperature at bottom of lehr canal.**

glasses ranges from 5500 to 8000 kg./mm.^{2} Soda-lime-silica glasses run from 5500 to 7500. The calculation of modulus is not feasible because essential factors are lacking.

Coefficient of Linear Expansion. Winkelmann and Schott's factors are useful for estimating the coefficient of linear expansion of glasses whose composition is known. However, experience has shown that the calculated values are only approximations because no truly additive relationship exists betwen the composition and expansibility of glasses. Values range from 36 x 10^{-7}°C. for a borosilicate of the Pyrex type to 99 x 10^{-7}°C. for plate glass, and as much as 12 x 10^{-6}°C. for high-soda tube glasses.

Utility of the Formula. Values calculated by means of the formula set forth above are sound for flat pieces, losing heat from both sides. From hollowware and cylindrical objects, on the other hand, heat is given out only from the external surfaces. Therefore, double wall thickness is reckoned for such ware. In fact, the maximum wall thickness of an article must always be taken. When glassware of different forms are annealed together, the least favorable data must be used; that is, the ones which bring out the minimum permissible cooling speed.

(b) This portion of the curve refers to one of the rapid cooling cycles already described continued to room temperature because, in this region, the glass can be cooled at a rate limited only by danger of breakage. The temporary strains that arise will all disappear when the ware is cold.

It is well to be able to predict a maximum rate of cooling, bringing about a temporary strain that the glass will stand, using the formula:

$$h = -7.24.10^{-3}.\frac{P}{S^2} = \text{°C. per min.},$$

when P does not exceed 600 Kg./cm.^{2} breaking stress.

Besides cooling speed, another important consideration exists. For each separate temperature point between upper and lower annealing temperature, there is a specific time necessary for complete removal of strain. According to Littleton and Roberts[4], the time required for the glass to become strain-free, at any temperature in the annealing range, is given by:

$$t = 10^{a(\theta_1-\theta)}$$

in which t = time in minutes,

a = a constant depending upon glass composition,

θ_1 = temperature, °C., at which strain is relieved in less than one second,

θ = temperature corresponding to time t.

The Investigation of Strain in Glass

By polarized light, glass in compression shows negative birefringence and in tension positive, when observed between crossed nicols. This phenomenon is useful for the identification and evaluation of strains. Examination is made by placing a gypsum plate, which shows first-order red, oriented at 45° to the planes of the crossed nicols. Strain-finders made on this principle are used by many firms. The observers see a colored field in such an apparatus. In what follows, it will be seen how the effective strains can thus be estimated.

Glasses that have irregular surfaces or are decorated must be examined in a more favorable medium-than air. The articles are placed in a glass trough filled with a liquid that has the same index of refraction as the glass. Such a liquid is benzol, to which carbon disulfide is added to bring the index to the required figure.

The red color of the gypsum plate corresponds to an optical-path difference of 530 mμ. If a birefringent material is now placed in the field, this red color changes toward blue, if the fast ray of the material has a direction of vibration parallel to that of the plate (a) because a rise in retardation results. On the contrary, if the direction of vibration of the fast ray of the birefringent substance is parallel to that of the slow ray of the gypsum plate (c), retardation is lowered, and the color tends to-

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THE GLASS DIVISION AT ROCHESTER

The city of Rochester, N. Y., has numerous industries, but its chief claim to fame, in the eyes of glass technologists, is the presence of the Bausch and Lomb Optical Company. From small beginnings as a shop for making spectacles in 1833, this plant has become a national institution, known the world over for optical glass and optical instruments.

As a part of the centennial celebration of Bausch and Lomb, the Glass Division of the American Ceramic Society was invited to hold its Fall Meeting in Rochester. The choice of meeting place was especially appropriate because Dr. Norbert J. Kreidl, Chairman of the Division, is Chief Chemist and Research Director for the company and thus served in a dual capacity as presiding officer and one of the hosts of the Division.

Headquarters were at the Sheraton Hotel, where rooms were adequate and the audience room, Starlight Roof, excellent for the technical sessions. In fact, this room, for arrangements and acoustics, is one of the best yet encountered in similar meetings.

Plant trips included inspection of instrument manufacture and opthalmic manufacture at B & L, and the ladies were taken to see the George Eastman House, now serving as a museum.

One of the distinguished visitors at the meeting was Dr. Ivan Peychés, Director of Research for Saint-Gobaine, France. Dr. Peychés entered the discussion of one of the papers, while Dr. Kreidl earned a round of applause for translating his remarks from French into rather more understandable English. This is not meant to insinuate that the subject matter of the discussion became completely understandable to many of the listeners.

Programs were arranged by a committee consisting of T. G. Pett, of Bausch and Lomb; F. W. Mowrey, American Window Glass Company; and J. W. Michener, Owens-Corning Fiberglas Corp. These men deserved praise for bringing together two groups of technical papers of high order, in line with the policy of the Division in devoting the Fall Meeting to scientific papers while reports of more general interest are made at the annual meetings of the Society.

The Friday afternoon session was a Symposium on "Infrared," under the chairmanship of H. G. McMahon, of Arthur D. Little, Inc., who skilfully introduced the subject and made a brief summary after the papers were presented. The paper on "Radiation and Heat Transfer" was prepared by H. Cole of Pilkington Brothers, England. The members were greatly disappointed because Mr. Cole was unable to make the journey. His presence has been enjoyed at previous meetings. His paper was read by Tyler Pett.

"Transmitting Materials and Filters" were ably handled by F. W. Glaze, National Bureau of Standards. Mr. McMahon summarized and led the discussion.

Charlie Pearce and his assistants from the Society's office in Columbus took care of registrations, which numbered 207 members, 30 of whom brought their wives.

Officials of Bausch and Lomb Optical Company were hosts at an extremely enjoyable social affair, a cocktail hour preceding the banquet on Friday evening. The banquet found the ballroom of the Sheraton well filled. After the excellent dinner, Dr. Kreidl spoke a few words of welcome to the B & L "birthday party," and introduced the people at the long head table.

Trustee Oscar G. Burch presented the awards founded by Preston Laboratories. D. A. McGraw, Research Glass Technologist with Owens-Illinois Glass Company, won the Meyer prize for his paper: "Method for Determining Young's Modulus of Glass at Elevated Temperatures" (*J. Am. Cer. Soc.*, January, 1952). P. W. Collyer, researcher with American Optical Company, won the Forrest Award with his contribution: "A Study of the Effect of Linear Pressure on Refractive Index Change in Glass" (*J. Am. Cer. Soc.*, February, 1951).

Mr. Carl Bausch, President of B & L, took time enough to get the audience well-acquainted with the brilliant career of the speaker of the evening, to recite his achievements in science, education and national service, and to tease him slightly about his hobbies.

Dr. George H. Harrison, Dean of Science, M. I. T., then delivered an after-dinner address that might well serve as a pattern for all such addresses. It was pungent and witty, with praise for the progress of science in glassmaking interspersed by gentle ribbings about shortcomings of scientists. If he did plug for making glass plastic in character and call the glass technologists "ceramic engineers," these departures were forgotten in the genuine pleasure and interest generated by his speech.

The program for Saturday morning is given below:

(1) "Transformation Range Phenomena in Borosilicate Crown Glass." H. N. Ritland, Corning Glass Works, Corning, N. Y.

(2) "Microscopic Investigation of the Adherence of Molten Glass to Heated Metals." H. V. Fairbanks, H. E. Cummings, Jr., and W. A. Koehler, Engineering Experiment Station, West Virginia University, Morgantown, W. Va.

(3) "A Comparison of the Stevels and Huggins Equations for Calculations of the Densities of Glasses from Their Compositions." M. L. Huggins, Research Laboratories, Eastman Kodak Company, and J. M. Stevels, Philips Research Laboratories, Eindhoven, Netherlands.

(4) "Glass Structure." J. W. Michener and J. G. Sayre, Owens-Corning Fiberglas Corp., Newark, Ohio, and A. F. Prebus, Ohio State University, Columbus, Ohio.

Dr. F. L. Bishop, next year's Chairman, had some practice in conducting the morning meeting.

In connection with the technical papers, which did seem slightly to go off the deep end into theoretical discussion, your reporter interviewed old "Dusty" Batchouse, who has been attending these meetings for many years.

"They are away over my head", said Dusty, "although a man has to admit that these speculations on structure will probably help us to understand how glass behaves, sometime, when we get a hook-up between atomic hook-up and glassmaking.

"Just now", he went on, "I'm less interested in the coordination than in the cordy nature of glass, and I couldn't tell a bond angle from a boondoggle. When they

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SUMMARIES OF TWO GLASS CONFERENCE PAPERS

Some Aspects of Controlling the Color of Glasses

By Axel Ottoson and Carl J. Uhrmann
Imperial Glass Company, Bellaire, Ohio

There are definite reasons for all color variations in colored or crystal glasses and in order to maintain the precise color of a glass, a number of factors must be given careful consideration.

First, cleanliness as it applies to a mixing room is of prime importance. It is essential that the mixer is cleaned thoroughly between the mixing of different colors so that there is no carry-over of coloring oxides from one batch to another. Contamination of the raw materials and cullet must be prevented in order to secure consistent results.

Accuracy in weighing is essential. Sensitive scales should be used and they should be kept clean and protected from dirt accumulation and breezes. The person doing the weighing should be free from distractions.

Light or pastel colors in which only small amounts of colorants are used are most troublesome. Because of the strong coloring effect of iron oxide, it is important to use raw materials of low iron content if it is desired to make delicate tints of colors which are complementary to the color of iron oxide in glass.

Powerful colorants when used for light colored glasses are best used in the form of cullet or in the form of mixtures. For example, the mixing of 2 pounds of powder blue with 18 pounds of feldspar for use as the decolorizer mixture. For each ounce of powder blue required, 10 ounces of this mixture is used thus minimizing weighing errors.

If nickel oxide is used as a colorant, the color of the glass must be repeatedly checked for nickel and seems to build up an increasing density of color as cullet containing nickel is returned to the batch.

The proportion of cullet used with a given batch should be kept as constant as possible. Varying the cullet charge will cause variations in the final color of the glass, particularly amber glasses. There are times when it is impractical to maintain a given or established cullet-to-batch ratio and in the case of an amber glass, the amount of graphite had to be increased as the amount of cullet was increased. For example, the following adjustments were found necessary to arrive at the same tint in the glass.

Sand	Amber Cullet	Sulfur	Graphite	
1000 lbs. batch	500 lbs.	5 oz.	17 oz.	(17)
750 " "	850 "	3.75 oz.	13½ oz.	(12.75)
500 " "	1200 "	2.5 oz.	11 oz.	(8.5)

(The numbers in brackets are the quantities of graphite which would be used if the graphite charge were kept in proportion to the sand.)

Another practice which has been found helpful in controlling color and also to minimize the difficulty of certain glasses becoming seedy upon working is to "rub" or "block" the glass during melting using a water soaked piece of oak or apple wood. Blocking is usually done about two or three hours before the glass is expected to be completely fined. Blocking can result in better color and longer pot life.

If the glass is melted in a day tank or continuous tank, particular attention must be given to the furnace atmosphere. If the batch is of an oxidizing character, it is important that the flame is oxidizing during the melting period. To insure such conditions, the air-fuel ratio must be so adjusted that there is about 2% oxygen in the furnace gases. In case neutral batches or reducing batches are used, a neutral atmosphere is desirable with no oxygen or carbon monoxide present in the furnace atmosphere. In all cases, flame impingement must be avoided to prevent color changes.

Furnace temperatures also influence color. Experience has shown that iron oxide has a tendency to be reduced from Fe_2O_3 to FeO at temperatures above 2650°F. Selenium decolorized glasses are less sensitive in this respect.

Occasionally, even when every known precaution has been taken to insure the proper color, the finished melt will turn out to be "off color." It then becomes necessary to adjust or "dose" the glass to make it suitable for use. If too dark, the addition of colorless cullet to the pot or day tank followed by reheating to the melting temperature and "blocking" will lower the color. Amber glasses that are too dark can often be corrected by the addition of a small amount of crystal batch to which has been added an extra quantity of sodium nitrate.

Should the color be too light, a small amount of batch with additional coloring material can be added to the glass followed by reheating and "blocking."

Not all "off color" melts can be saved, but enough of them can be turned into production to make the effort worthwhile. It should take only six to eight hours to "dose" a pot as compared to 28 to 35 hours for ladling out the faulty glass and remelting a new batch.

Factors Influencing Plant Design For the Production of Glass Containers

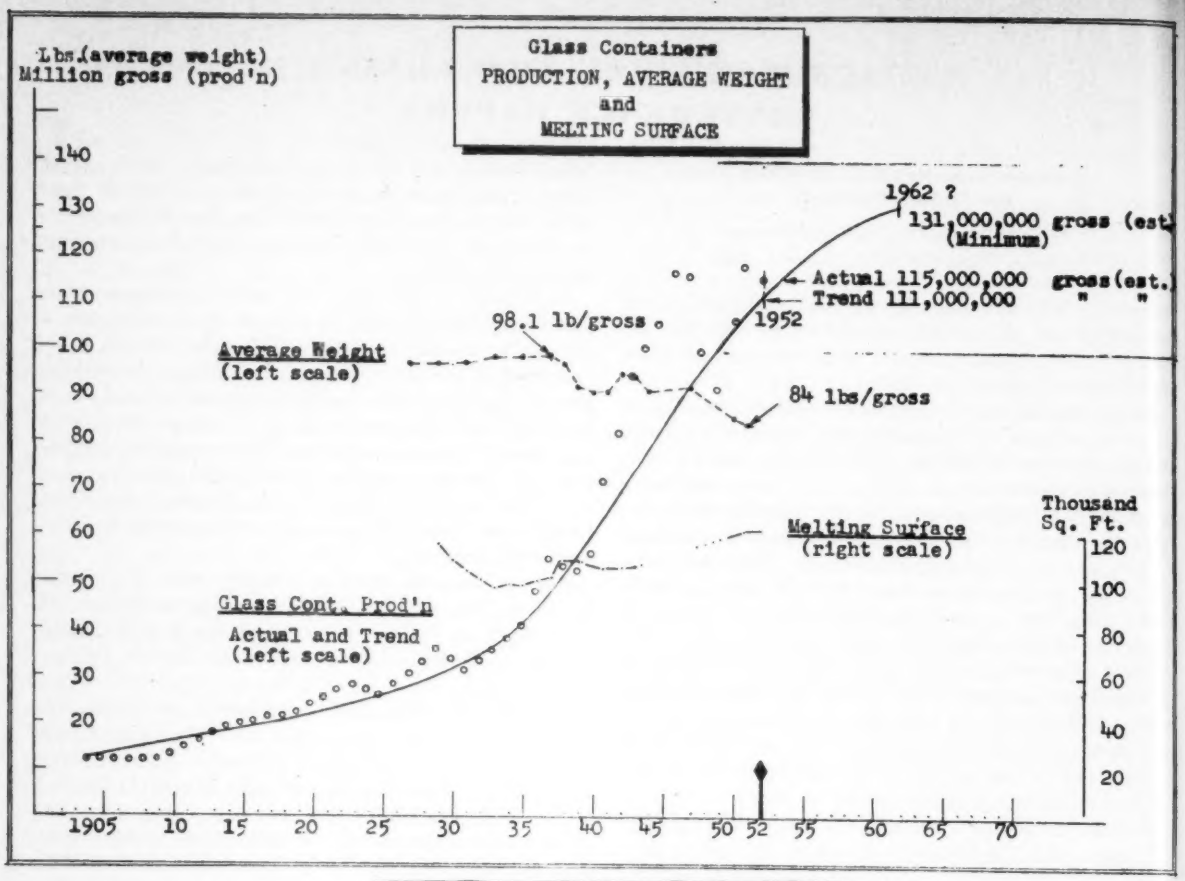
By Morton Cressy
Hartford-Empire Company, Hartford, Conn.

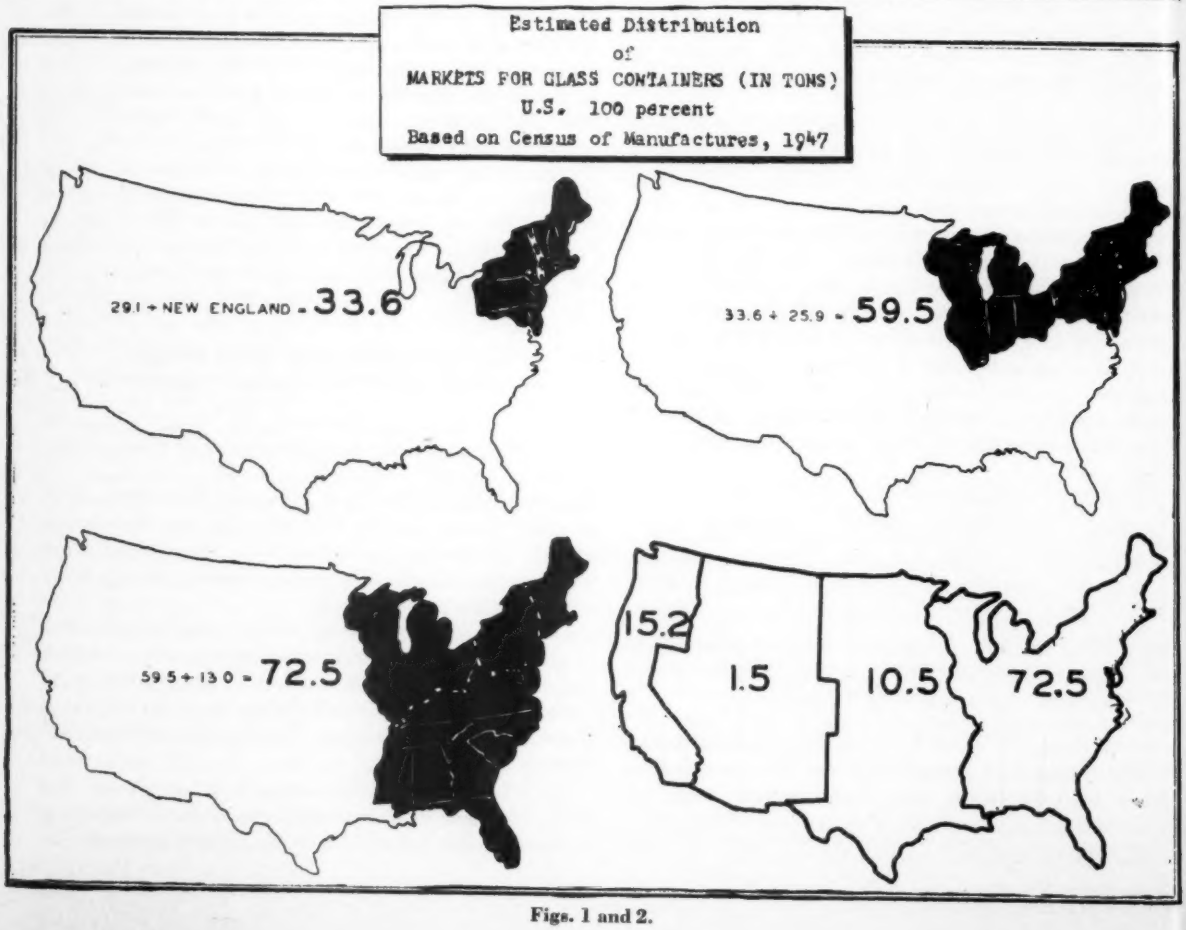
The successful production of glass containers is the result of many factors, not the least of which are such fundamentals as markets, plant locations, plant layouts, furnaces, machines and, perhaps, contemplated developments of forming machines.

First and foremost in the factors is the growth curve of the glass container industry shown in Fig. 1, which indicates the tremendous increase in the production of containers for a very small change in melting area of furnaces that has taken place. This has been accomplished through:

(a) The development of faster working glasses. Between 1940 and 1950, improvements in glass composition were responsible for a 6% increase in forming speeds and

These papers were presented in full before the Thirteenth Conference on Glass Problems, Ohio State University, Columbus, Ohio.


Glass Containers
PRODUCTION, AVERAGE WEIGHT
and
MELTING SURFACE
Lbs (average weight)
Million gross (prod'n)
140
130
120
110
100
90
80
70
60
50
40
30
20
1962 ?
131,000,000 gross (est.)
(Minimum)
Actual 115,000,000 gross (est.)
Trend 111,000,000 " "
1952
98.1 lb/gross
Average Weight
(left scale)
84 lbs/gross
Thousand
Sq. Ft.
Melting Surface
(right scale)
120
100
80
60
40
20
Glass Cont. Prod'n
Actual and Trend
(left scale)
1905
10
15
20
25
30
35
40
45
50
52
55
60
65
70


Estimated Distribution
of
MARKETS FOR GLASS CONTAINERS (IN TONS)
U.S. 100 percent
Based on Census of Manufactures, 1947
29.1 + NEW ENGLAND = 33.6
33.6 + 25.9 = 59.5
59.5 + 13.0 = 72.5
15.2
1.5
10.5
72.5

Figs. 1 and 2.

from 1950 to 1952, this figure increased to 15%, and further gains are expected.

(b) Reduction in the weight of containers has permitted an increase in number. The average weight in 1930 was about 96 pounds per gross and in 1951 it was 84 pounds per gross.

(c) Productive capacity was increased by the 24-hour, seven-day week.

(d) Major improvements in the design and operation of melting furnaces have provided more glass.

(e) Better scheduling of production has resulted in more efficient use of plant capacity.

(f) Improvements in equipment have made it possible for a given machine to produce many types of ware at high speeds for each type.

(g) Standardization of the design of containers has increased efficiency.

(h) The availability of better refractories to provide longer service life at higher temperatures has reduced down-time.

Figures 2 and 3 show the concentration of glass container markets and the estimated distribution of furnace melting areas, respectively. At one time the availability of cheap fuel was the determining factor in selecting the location for a glass plant. Years ago it required approximately 60 million BTU per ton of glass. Now, normal operation calls for seven million BTU per ton or less.

Approximately 80 container plants in the U. S. have a total of about 235 melting furnaces ranging from 100 to 1100 square feet of melting area. The preference appears to be for furnaces having melting areas between 400 and 700 square feet, with the average being somewhat over 500 square feet. Assuming an average melting area of 550 square feet and a pull of about 6 square feet per ton per day, approximately 90 tons of glass are pulled per furnace per day. This represents the average requirements of 4 or 5 shops, the industry average being about 4.5 shops per furnace.

Due to the large increase in freight costs, the plant located close to the market it serves has a definite economic advantage. A detailed analysis of the combined cost of batch and fuel shows that in most cases these costs make little difference in where a plant is located. There may be a saving on one or the other, but the combined cost differs very little for most manufacturing areas.

The preferred furnace in the container industry seems to be one with a minimum of four shops and a maximum of six. Experience indicates that a five-shop furnace, with allowance for six shops at a later date, would be the most interesting to a container manufacturer considering replacement of older furnaces or possible expansion. The container industry has a reputation of long standing for trying to increase plant productive capacity well beyond its original design. Therefore, in determining the size of a plant, provision should always be made for at least 20% expansion. It is good policy to provide spares and utilities for six-shop operation in the design of a five-shop plant.

Considering six square feet per ton per day to be the

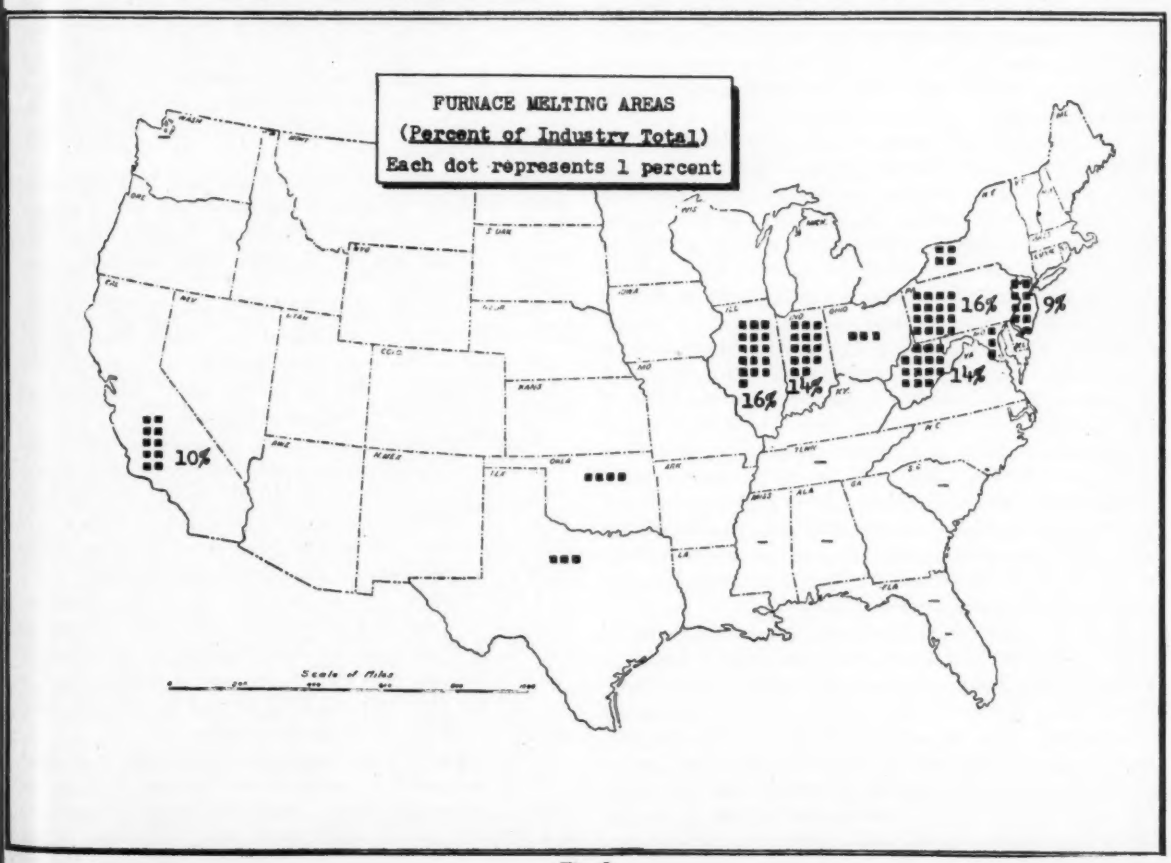


Fig. 3.

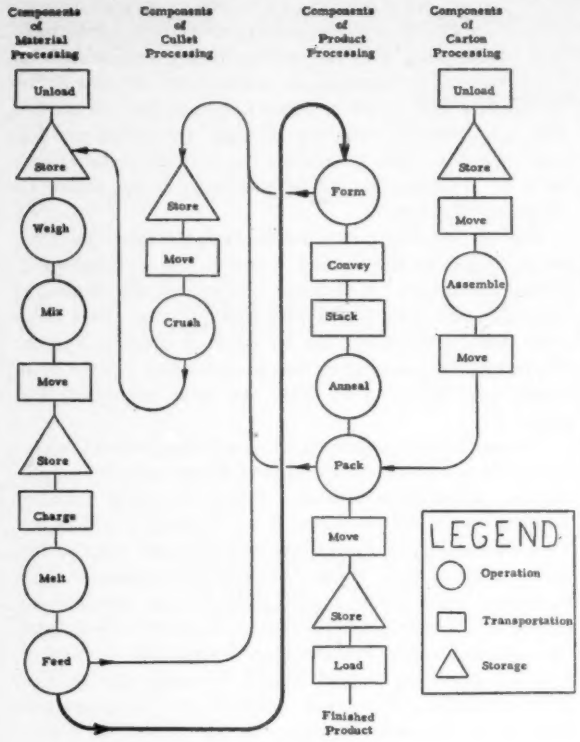


Fig. 4.

average pull, the design should anticipate this average pull for start-up, but the furnace would be expected to do better most of the time. The furnace would have a melting area of 792 square feet and ample capacity for a sixth shop.

The estimated minimum cost of a five-shop plant, including a batch plant costing a quarter of a million dollars, the furnace, feeders, forehearths, I.S. machines, stackers, annealing lehrs, air compressors and all other necessary accessories installed and ready to operate, is about $2,000,000. This figure also includes land, railroad sidings, road and other improvements, as well as utilities and general service equipment.

With proper scheduling and a normal range of ware weights and types, both norrow neck and wide mouth containers can be produced, having a salable value of approximately $3,500,000 per year. Additional capital is needed to finance accounts receivable, inventories, molds and the like. The total amount of these requirements varies from plant to plant depending on the circumstances, but may be estimated at $700,000 to $1,000,000 for a five-shop plant, making the total capital needed for a new plant $2,700,000 to $3,000,000, or something like 75-85 cents per annual sales dollar.

There has been designed a small plant capable of expansion for which demand has been generated by new market areas. This is the single-shop plant using a Hartford-Empire Company unit melter. Careful studies and comparisons have been made of the over-all operating cost, including fuel and refractories, for a unit melter vs. a regenerative furnace of comparable size. The results of these studies clearly indicate that, from an over-all operating standpoint, the unit melter has definite economic advantages and that it provides an inexpensive means for the individual manufacturer to expand his market for glass containers.

Studies are being made to determine the economics of locating unit melters and single-line production units close to the markets they serve. In many cases, the savings in freight alone far outweigh the additional cost of single-shop operation and, at the same time, the customer is provided maximum service.

A typical one-shop set-up would have a 6 x 36 unit melter having a daily capacity of about 30 tons of soda-lime glass and would include forehearth, feeder, I.S. machine and annealing lehr. The estimated cost of this plant, complete with batch storage, mixing and handling facilities, furnace, glassmaking equipment, automatic cartoning equipment and everything installed ready for operation, is $490,000. The containers normally produced by this unit melter have an estimated annual sales volume of about $700,000. Accordingly, with working capital estimated at $140,000, this would bring the total investment to about 85 cents per annual sales dollar.

As an aid in visualizing the various steps in container production, the flow chart, Fig. 4, shows the breakdown of these into the three phases of operation, transportation and storage. These fundamental operations must be carried out regardless of plant size. Accordingly, for the five-shop plant, a relatively large amount of automatic equipment can be justified for such operations as unloading, weighing, mixing, etc., but for the single-shop plant, there is an economic limit to investment in automatic equipment.

Batch storage facilities should be sufficient for at least ten days' operation and preferably fifteen or twenty days so as to be independent of interruption in supply such as may be caused by strikes or material shortages. It is recommended that the batch scales be equipped with devices for printing individual weights for their psychological advantage.

The furnace should be side-fired, have fully automatic batch chargers, glass level control system and a reasonable amount of furnace operating controls. The forehearths should also be provided with automotic temperature controls.

When properly arranged on a mezzanine balcony, automatic cartoning equipment can reduce costs appreciably and at the same time provide an uninterrupted supply of cartons. Several plants report reductions of 50% in cost of carton making operations.

Regarding ware-shed capacity, 30 days' storage meets minimum requirements for active ware types. For single-shop operation, allow about 10,000 square feet of floor area in a building 14 feet under the trusses. With a five-shop plant, this can usually be reduced to about 8,000 square feet per shop for the same building height.

While Bunker "C" oil provides more than twice as many BTU's per fuel dollar, it is sometimes cheaper to use No. 2 oil as a standby fuel, especially in areas where gas shut-offs are rare due to the cost of heating Bunker "C." If gas shortages are frequent and of relatively long duration, Bunker "C" is the best choice.

When designing the compressed air system, it is good practice to provide for some excess capacity, 20% excess being a reasonable figure. Individual small compressors are favored over a single large unit. Individual after-

(*Continued on page* 635)

GLASS PROGRAM DRAWS LARGE ATTENDANCE AT WEST COAST MEETING

The "cable-car" city provided flawless weather for the Sixth Pacific Coast Regional Meeting of the American Ceramic Society held October 22, 23 and 24. Registrations were close to 350 which testifies to the growing interest and popularity of the West Coast yearly meetings.

The theme of the general opening session was "Ceramic Research." President R. R. Danielson discussed this subject in a general way giving credit to the many agencies who are contributing. W. F. Dietrich of the U. S. Bureau of Mines reviewed the extent of the work being carried on by the various agencies in that Bureau, and C. H. Hahner, Chief of the Glass Section of the Bureau of Standards, briefly reviewed the scope of activities in progress in the various sections as far as they contributed to ceramic research, which includes work in progress on the physical properties of glass, particularly the studies of two component glasses. He then outlined the broad scope of activities within the U. S. Bureau of Standards, particularly those pertaining to ceramics.

Representatives of the glass industry were favored by discussions pertaining to problems of 1953 production. The first presentation was by Larry Penberthy, who discussed "The Role of Convection Currents in Producing Better Glass." Many papers have been written on this subject over a period of many years, but at no time have the demands on melting tanks been as heavy as they are at present. More knowledge is needed regarding convection in tanks because of the unexpected efficiency of electric melting, particularly the introduction of bottom heating by means of electrodes, namely "booster" melting.

This is the time to reconsider the factors that influence the melting of the batch—the fining and homogenizing of the glass, and the effect of tank design on the operation. Aspects of tank design to be considered are depth, throat size, insulation and melting characteristics in general. Reference was made to reboil characteristics of glasses, some of which are more susceptible to gas release than others. Along with more exact knowledge of glass melting, the industry can expect radical changes in tank design.

A. K. Lyle's paper, "Color Changes in Continuous Glass Melting Furnaces," was based on work reported earlier by the author in which a higher density glass replaced one of a lighter density. In that particular work, the time for the appearance of the new glass was observed, as well as the over-all time involved for the complete changeover. The data was then expressed as a formula which can consistently be applied to any commercial glass tank with a remarkable degree of accuracy. Having once established the time for the replacement of the old by the new glass, the formula works admirably for shortening the time of changing from one color to another. Lyle reports one case where good color amber was coming from one feeder and good flint glass from an adjacent feeder. This freakish result very vividly illustrates the fact that glass passes through a tank at different rates of flow.

Frank W. Preston made his first appearance on a West Coast Regional Meeting Program by presenting a talk entitled "The Shoe on the Other Foot." This very philosophical approach to the authenticity of data characterized the keen thinking of the speaker, who gave two or three case histories where much experimental work could have been eliminated had the problem been analyzed differently.

A paper entitled "Optical Methods for Determination of Iron in Glass Sands," was presented by Robert J. Campbell of the University of Washington. The procedure used, in part, consists of comparing the color of a test bar of glass, melted from a sample batch containing the sand being tested, with a standard series of glass bars made from chemically pure materials of measured iron oxide contents. Using the Beckman spectrophotometer, the sample, which is three-eighths by three-eighths by three inches in size, is then examined in an immersion liquid.

Of particular interest to the glass group were two papers dealing with the Corona and Del Monte Sands. In a paper entitled "Flotation of Del Monte Sand," William E. Messner described the operation of the plant, with special reference to the flotation process. This talk was supported by a film showing the operations wherein feldspar is separated from quartz. Part of this operation consists in using a mixture of Hydrofluoric Acid, Armac "T" Amine, Kerosene and Pine Oil. The Del Monte plant has one of the most modern sand operations in the country.

Inasmuch as over 50% of the glass produced in the Los Angeles area is made from Corona sand, much interest was shown in the contribution by Lewis T. Brown, of the Owens-Illinois Glass Company, entitled "By-Products from the Corona Sand Deposit." The Corona sand mill, which is located about 60 miles from Los Angeles, supplies two grades of sand containing about four per cent alumina and about three per cent alkali. One of the sands is for the manufacture of colored glass.

Magnetic rejects alone amount to about 200 tons per month, and the total annual production of by-products is about 80,000 tons, which at present are stockpiled and awaiting a market. The properties of these many by-products were discussed, along with their possible uses.

The refractories group contributed three papers of much value. "The Use of Clay Flux Block" by J. J. Duggan of Walsh Refractories Corp. reviewed the cost of rebuilding a typical tank. Mr. Duggan started with a 100 per cent flux block tank, and ended up with a 100 per cent fused cast tank.

James C. Hicks of Kaiser Aluminum and Chemical Corp. discussed the use of basic refractories in the glass industry and supported his talk with color slides, some of which were typical installations and others photomicrographs.

The final paper of interest to the glass group was by Harold Baque of Corhart Refractories Company who reported on "Fused Cast Block Paving." This talk was also supported by slides.

In October 1954, the West Coast Regional Meeting will be in Los Angeles.

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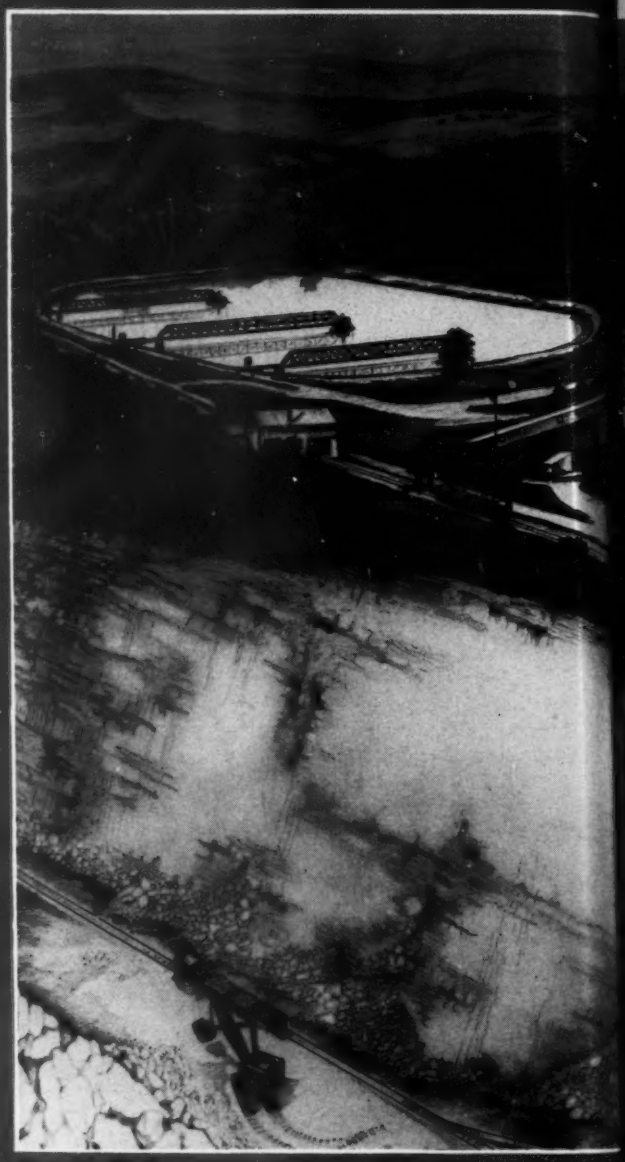

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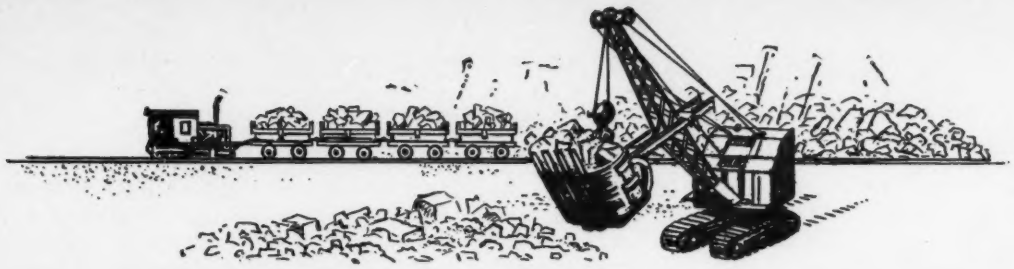

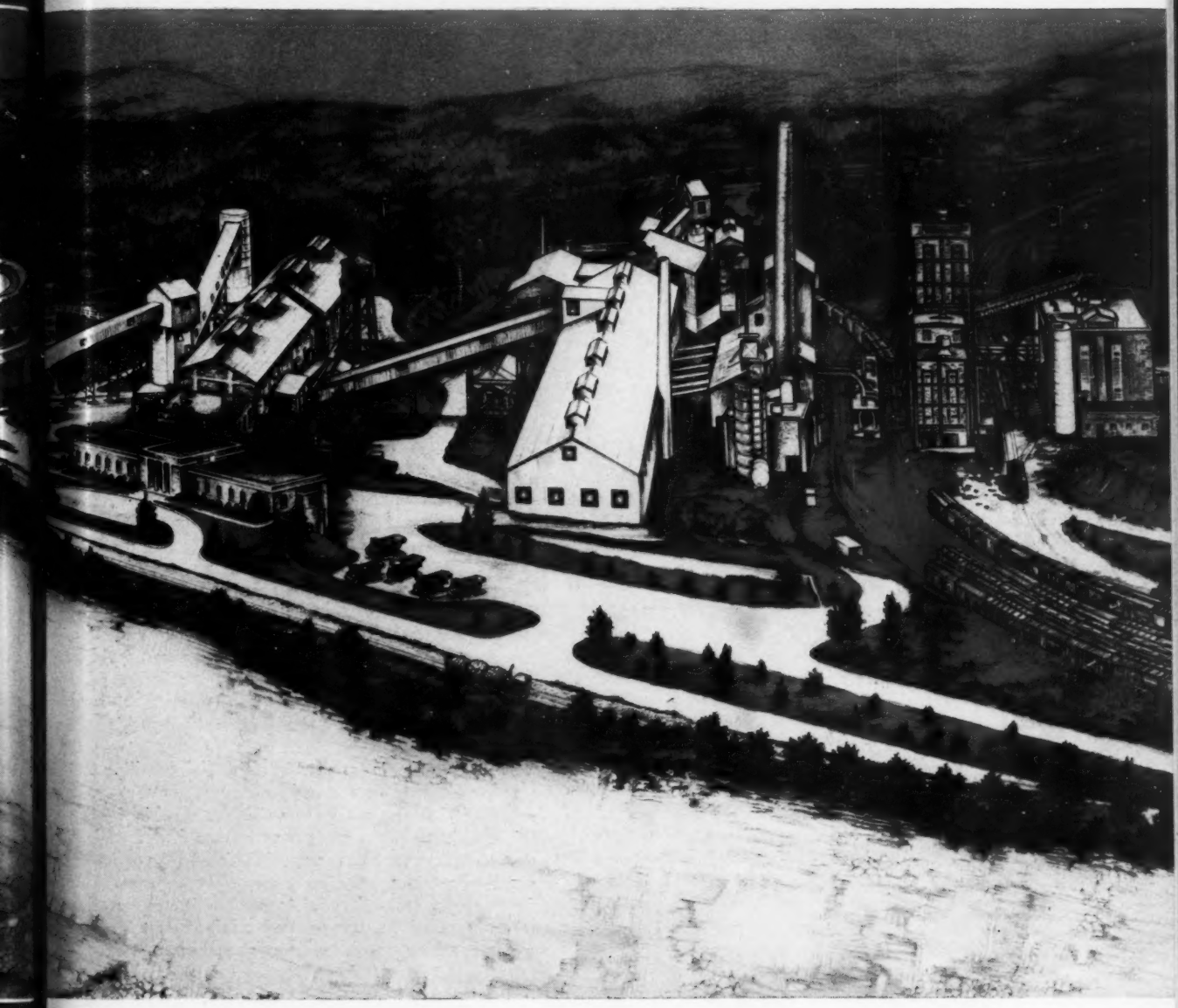

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GLASSHOUSE SAFETY PROBLEMS DISCUSSED AT NATIONAL SAFETY CONGRESS

Interest in the organized drive now under way to bring down the accident record in the nation's glass and ceramics industries continues to mount, it was indicated at the annual conference of the National Safety Council's Glass and Ceramics Section in Chicago, October 19 and 20.

Reporting at the Section's opening session, T. R. Donaghue, Safety Director, Pittsburgh Plate Glass Company and General Chairman of the Section, said 17 new members had been added to the roll during the past year, bringing total membership of the Section to 51 firms. While this modest number still leaves much to be done, Mr. Donoghue considered the 50 per cent increase a flattering testimonial to the energetic missionary work of the various committees and leaders who have helped during the past year. The Section is still one of the smallest in the National Safety Council and Mr. Donoghue asked for redoubled effort by everyone to keep the good work growing.

He paid special tribute to the splendid work of the Section's News Letter committee, composed of James L. Morris, Federal Glass Company, Clinton Ballenger, Owens-Illinois Glass Company and M. E. Hormberg, Cambridge Tile Mfg. Company. Mr. Morris has served as News Letter Editor for two years and through this medium of communication all members of the Section have been kept in touch with activities under way, provided with freely exchanged information on what individual members are doing and inspired with enthusiasm to support the Section's laudable program.

First order of business following the chairman's remarks was the election of 1953-54 officers. J. C. Dittmer, National Lead Company, as chairman of the nominating committee, presented the following slate: *General Chairman,* W. G. Hazard, Owens-Illinois Glass Company; *Vice Chairman (glass)*, Harry A. Jackson, Frigidaire Division, General Motors Corp.; *Vice Chairman (ceramics)*, Nelson B. Ingalls, The Norton Company; and *Secretary*, J. H. Gattrell, Blue Ridge Glass Corp.

Following unanimous election of these officers, committee assignments for the new year were announced, the chairmen of which will be the following. *Program,* Clyde C. Ruddick, Pittsburgh Plate Glass Company; *Membership,* Harry A. Jackson, Frigidaire Division, General Motors Corp.; *News Letter,* Karl W. Steinkraus, Owens-Illinois Glass Company; *Safety Promotion,* H. V. Gardner, Owens-Illinois Glass Company; and *Safety Contest,* John B. Fullen, Kopp Glass, Inc.

Chairmanships of the committees on Engineering and Health and on Associations were left open for later assignment. National Safety Council representative to work with the Section and correlate its activities with Council operations is L. W. Dutton.

Retiring Chairman Donoghue received from the Council a framed scroll expressing appreciation for his cooperation during the year in promoting safety in the full spirit of the movement guided by this great national organization.

For the constructive and inspiring discussion periods which followed on Monday and Tuesday, the Program Committee, headed this year by John P. Stephenson, Ball Bros. Company, and including James L. Morris, Fred G. Anderson and J. C. Dittmer, had lined up four authoritative speakers. Subjects they handled dealt with inspection procedures, control of oil fires in bottle molding operations, the Frigidaire Division's model safety program and the problem of noise control in industrial plants.

"Don't hire an accident" was, in substance, the theme of the first speaker, John Cruickshank, Chief Engineer, Federal Insurance Company, whose topic was "Plant Inspection For Safety."

In going through plant after plant following a disaster, Mr. Cruickshank commented, those making the inspections are impressed with the fact that much could have been avoided, if only someone had not slipped somewhere. One fire, occurring during the critical war period, he related, destroyed one-third of the nation's rubber supply all because a watchman shut off the sprinkler system by mistake.

Inspections to spot plant hazards, he said, will not alone stop accidents. Much of the problem involves personnel matters. When men, for instance, fall off ladders, the inspection should not stop at examination of the ladder's condition. In an aircraft plant three men sustained fractured skulls and one broken back in falls from ladders that were in O.K. condition. Not until after the accidents was it discovered that one victim was a diabetic subject to dizzy spells, and another a veteran bench worker unaccustomed to work in high places.

"What really happened," he said, "was that the employment department hired three accidents that might have been anticipated."

"Keep a spoilage record," was his next suggestion. On a floor plan, broken down into zones, pins should be stuck marking where a machine had been damaged, a platform or back stairway broken, a truck overturned, etc. Investigation should then determine why this spot produces accidents.

"Keep a list of equipment," he continued, recalling that he once asked a plant manager how many motors he operated. The man said it was 480, but to this list Mr. Cruickshank added another hundred he had found in water coolers, portable floor machines and other equipment overlooked by the manager. "My company," he said, "once had five fires in August, all in refrigeration equipment which had never been serviced by the cleaning crew and the overloaded machines had started flash fires in the dust behind them. 'Plug it in and forget,' the remark often heard about appliances," he said, dryly, "might well be included on the list of 'famous last lines.'" A closely scheduled maintenance program, covering all equipment would, he declared, prevent the results of this indifference to many prevalent hazards.

It might be well, he went on, to log the mileage on elevator cables. They are designed to carry, maybe, 180 persons or a loaded truck, but not forever. Cables wear out and knowing the mileage will help determine when a replacement is in order, if an inevitable accident is to be avoided.

"Consider your plant from the catastrophic point of

view with close regard to perimeter hazards," he recommended. Everything was O.K. at Texas City, he pointed out, until a ship with a cargo of ammonium nitrate docked next door to one plant and began unloading.

"In my work," he said, "I follow after many misguided but well meaning people. They are creatures of habit and don't like to change. One way to eliminate hazards is to substitute one of the '3 M's' of our work—either men, methods or materials." Illustrating, he told how he had sought the reason for 16 hernias among a materials handling crew. A study of the floor diagram, showing their route, led to rearrangement of the shop, which eliminated unnecessary handling operations, reducing thereby the handling crew by nine men and, with fewer men exposed to the risk, the hernia record was also reduced. He told, too, of how one manufacturer avoided heavy expenditures for protective devices, ordered by military inspectors, simply by substituting a new safe solvent for one previously used, which had entailed great potential hazard to the workers. "Relocate or isolate operations, such as sand blasting or paint spraying, to reduce the number of persons exposed to possible injury," was another of his suggested rules. Still another was, "Make hazards conspicuous by light, noise, color or signs."

Last on his list of things to do, in addition to routine inspections, was "Keep hammering at the foreman." "Never take responsibility for accidents away from your foreman," he advised. "Never accept his alibi that 'It was inspected just yesterday.' Make him realize that inspection is not everything in accident prevention. If the man is 'accident prone' on the job assigned to him, he should, for his own safety's sake, be shifted to another job."

Fire losses in the major bottle forming plants have approached a 200 per cent increase in the past ten years, E. J. Sestak, Chief Engineer, Factory Insurance Association, stated in his paper on "Fire Prevention in Glass Forming Departments." In contrast, he added, the increase has been only from 25 to 30 per cent in plate glass and allied glass products factories.

"As engineers and underwriters," Mr. Sestak declared, "we have a moral obligation to find means for controlling and eliminating this tremendous loss. Your industry has cooperated most wholeheartedly in our study of results from numerous fires of related origin."

In bottle plants, he pointed out, the problem is extremely difficult due to many factors—the oily concentrate sprayed over wide areas, the paraffin oil spray on molds, the oily condition of the machines, the open gas flame, the molten glass and the continuous operations under high heat. Fires can be started from many causes —the escape of hot molten glass, ignition of floor oil deposits, hot gas from a ruptured line, open gas flames, welding sparks, electrical defects in the machine and malformed bottles.

Underwriters have suggested a number of changes, he said, but it is not felt that the industry has gone far enough in adopting these recommendations. He recognized the problem's enormity and that the industry cannot act too hastily. If, however, any recommended change encourages hope for abatement of the hazard, he felt that it should be promoted.

New low hazard oils could be developed, through research, he declared, and flash fires could be reduced by eliminating or controlling oil condensate on the surroundings of the machine. Cleaning, in addition to frequent swabbing, should also include thorough cleaning with steam and a detergent when the machine is shut down. He spoke also of patented ventilators to catch the oil laden upward draft and conduct it safely away from roof members and materials. Study of the bottle forming machines might also reduce elements contributing to fires. In starch-making operations, he recalled, the fire hazard was reduced by machine design improvement.

"We are not telling the glass industry how to run its business," Mr. Sestak said, "but your problem certainly warrants study. Sooner or later you will face a fire in your plant. Any means for meeting such emergencies must be largely tailor-made to fit your conditions. Your big problem is to find means for checking the oil condensates at the source, and that isn't hopeless. The corn processing industry licked their dust hazard and it has been done in fiber-using factories. Your problem is a challenge which you should accept and master."

Following the reading of his formal paper, Mr. Sestak, at the request of Chairman Donoghue, related some of his observations made while inspecting the ruins of the General Motors transmission plant at Livonia, Michigan, following the disastrous fire there August 12.

At Tuesday afternoon's session, Mr. Donoghue turned the gavel over to the newly-elected Chairman, W. G. Hazard. Commenting on the comparative youth of the Section, Mr. Hazard recalled that glassmaking was this country's first industry started in the Jamestown colony by five indentured Poles. This group, he also noted, staged America's first strike when they sought a franchise as free citizens of the new country.

The glass and ceramics industries, he remarked, has a venerable history, but has been rather slow in getting started on an organized accident prevention program. Progress would be faster, he declared, if more industry members would come forward to help carry on the movement. He appealed for recruits to come forward and fill the ranks of the task forces—the committees—on whom he, as general chairman, must depend in the year ahead.

P. F. Bunger, Safety Director of the General Motors' Frigidaire Division, in outlining the safety program in effect at Dayton, said various hit or miss systems had been tried but none had been wholly successful until, in 1946, the safety department was organized as a full-time activity with himself as director.

"I had been in sales for 15½ years," he said, "so I set up a sales promotion campaign to sell safety to our employees. We still have accidents, but no other company, so far as I know, can show the interest in safety taken by our top management."

On the second Tuesday of every month, he went on, the executive safety policy committee meets. Frigidaire's General Manager is chairman and membership includes the chief engineer and every other individual whose regular duties make him a party to accidents. At first they used to go over the written reports of the previous month's accidents, which eventually seemed to "put them to sleep." So three Graflex cameras were purchased and the seventeen men on Mr. Bunger's staff were trained to use them at accident scenes. Slides showing conditions surrounding the accident are now shown at the policy group's conferences, where they are gone over as a surgeon examines an X-ray. "Buying these cameras," he

said, "was the best thing we ever did. Shop foremen know where the pictures are to be shown and they don't like it, because it may reveal where the foreman was at fault."

Later, the general manager suggested that pictures be made of hazardous conditions spotted by the safety men around the plant. So the staff went out, armed with the cameras and flash bulbs but minus films. Fifteen minutes after the supposed picture is made, he said, a return visit to the spot would show that the objectionable condition had been corrected.

Following the monthly policy committee meetings, each of the several plant managers meets with his top safety people where, again, the accident pictures are shown with some bona fide shots of poor housekeeping. Plant managers and department foremen also get a monthly bulletin suggesting subjects on which talks must be made to the men in the lower echelons of the working force. Reports must also be sent back to the safety department, stating the time of those shop meetings, their subject matter and other pertinent data.

In addition to the seventeen men, Mr. Bunger also has four women on his staff. One man specializes on punch press accidents, another on cabinet making and four are eye protection experts who also handle the room where eye protection supplies are kept in stock.

Frigidaire's eye protection program saves an average of 60 eyes a year, Mr. Bunger said. Men at first objected to goggles but, after foremen were required to set the example in wearing them, this opposition ceased. All goggles are fitted on prescription orders, so that they are adapted to the man's condition and the work he does.

One secret of the entire program's success, Mr. Bunger continued, is that each department has its own job safety manual, authored by the foreman, but with assistance from the safety department to correlate the information.

"The foreman writes it," he said, "so he is interested in seeing that his rules are followed. He goes over the book with each new employee, and makes the man sign a statement to the effect that he fully understands the hazards of his job and how to avoid them.

The safety department is also responsible for creating the "homey" feeling among employees which is lacking in some large industrial organizations. When an employee enters a hospital, the safety department immediately loans him a radio and sends along a letter, also sees that he gets a carton of cigarettes each week while in the hospital. When fatalities occur, a foreman is required to notify the family in person, taking with him a safety man to explain just how it happened, and also a registered nurse from the medical department, in case her services are needed with the bereaved family. "It all helps our constant striving," Mr. Bunger concluded, "to make our employees feel that somebody really cares."

The realization that industrial noises impair workers' hearing and affect their efficiency has given tremendous impulse to the noise abatement movement, Walter F. Scholtz, Supervisor, Hygiene Engineering Division, Allis-Chalmers Mfg. Company, declared in the fourth and final discussion at the Chicago conference. One thing making noise abatement important, he pointed out, is the sudden recent increase in compensation claims filed for hearing losses resulting from exposure to high intensity sounds. He referred to a recent Wisconsin court ruling which, he indicated, has significant bearing in establishing the validity of those claims. Several states have statutes requiring compensation for hearing losses incurred on the job and this trend, he thought, will doubtless spread to other states. (In Illinois, it can be added, a law making loss of hearing compensable failed of passage at last winter's session of the legislature. At the October convention of the Illinois Federation of Labor plans were approved to renew efforts for enactment of this measure when the legislature meets in 1955. *Editor's Note.*)

Allis-Chalmers, Mr. Scholtz asserted, feels that its recently established noise abatement program has made a good start and will ultimately arrive at control of the noise problem. First step to be taken in any abatement campaign, he continued, is to purchase an inexpensive instrument known as a sound meter. Making a spot check with this, areas can be located where the volume of sound exceeds the critical level, arbitrarily established at 95 decibels, and hearing impairment starts. A complete and thorough sound level survey of the entire plant should follow and periodic surveys should also be made to check new noises introduced by new, repaired or transferred equipment.

Once the origin of the noises has been identified, steps to abate them can begin, he went on. In one instance at his plant, metal machine guards, which were producing an excessive unnecessary noise, were replaced by wire guards which lowered the noise level at this machine by ten decibels. On a six-spindle automatic screw machine mufflers were placed on air vises and air punch operations, which lowered the sound level from 94 to 79 decibels. Tar is being applied to tumble barrels and metal skid boxes and from this a notable reduction of "sound effects" is anticipated, he said. Other noise areas are being worked over and although they present some difficulty, it is hoped that significant abatement of the noises can be accomplished.

He told, also, how application of acoustical board to walls of the room where the automatic office business machines were operated had resulted in one of the most significant reductions in noise anywhere around the plant.

Summing up this phase of the program, he declared that reduction in sound levels of from 8 to 10 decibels can be made "through good maintenance of machines and equipment," and that changes required can be made without expenditure of unduly large sums of money. Allis-Chalmers is also interested in the personal hearing abilities of all its employees, Mr. Scholtz continued. An audiometric examination, he said, is a part of every physical examination. In 6,000 such pre-employment examinations, 27 per cent were found to have some hearing loss and most of them didn't know it. If the new man is placed in an area where the sound level is at the critical 95 decibel point, or above, his hearing is checked after the three-month probationary period, again after six months and yearly thereafter. If the check shows a significant loss of hearing, the employee is provided with the best possible ear protection device suitable for his condition and he is also referred to the otologist in the medical department for further study.

"We cannot find any justification," Mr. Scholtz stated, "for transferring the worker to a less noisy job unless his hearing loss has progressed despite the protective devices provided for him." The audiometric room, he went on, is a part of the plant's first aid facilities. Here a fairly

(*Continued on page* 636)

Inventions and Inventors

Annealing and Tempering

Protective Coating for Front Surface Mirror. Patent No. 2,647,441. Filed April 27, 1945. Issued August 4, 1953. One sheet of drawings (none reproduced). Raymond W. Boydston and Allen J. Eshner.

The properties of front surface mirrors have been greatly improved by an overcoating of magnesium fluoride. By the unique use of a half wavelength thickness of vacuum-baked magnesium fluoride, the mechanical strength, optical reflectivity and durability of the metallic coating was greatly improved.

It was found that desired reflectivity and hardness increases may be accomplished not only by application of a half wavelength thickness of magnesium flouride, but also by other exact multiples, such as twice and three times the half wavelength value. However, for best results (maximum reflectivity increases) and simplicity of application, the use of the half wavelength optical thickness is preferable.

The recommended temperature for the baking process ranges from 300 to 500°C. Preferably, the optical element to be coated is heated in vacuum before deposition of the fluoride. Heating is then continued through the depositing stage.

The process can be used with U. S. Patent No. 2,443,196, June 15, 1948, Raines-Boydston-Eshner, in which front surface mirrors are produced by the thermal evaporation of aluminum.

The patent contains four claims and 11 references were cited.

Feeding and Forming

Automatic Glass Bulb Feed. Fig. 1. Patent No. 2,649, 214. Filed April 3, 1952. Issued August 18, 1953. Three sheets of drawings. Assigned to Westinghouse Electric Corporation by Joseph J. Kirby and Michael E. McGowan.

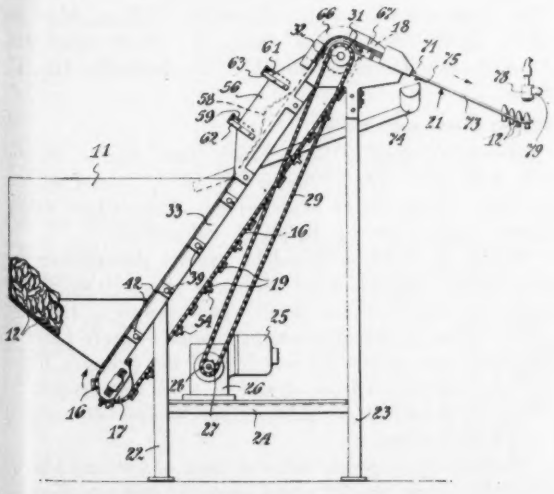


Fig. 1.

This invention relates to a machine for feeding open flared-neck lamp bulbs to a gravity track for transfer to a sealing machine.

The hopper 11, as shown in Fig. 1, is provided with a supply of bulbs 12 of the character specified. The motor 25 is placed in operation, causing rotation of the sprocket wheels 18 and upward movement of the upper sections of the chains 15 and 16. This movement not only agitates the bulbs in the hopper, but carries some of them along the chains, up to the top of the sprocket wheels 18, into the narrowing discharge portion 67 and finally on to the gravity track formed by the rods 71, 72 and 73. Because of the weight distribution, the neck or cullet portions 14 of the bulbs 12 drop down between the rods 71 and 73, the closed or larger portions 13 being supported between. The bulbs thus stand upright on the track and continue to feed to the lower portion until they approach a position adjacent the top end of the rod 72, whereupon excess bulbs instead of backing up along the rod 71, discharge into the chute 74 and are returned to the hopper 11 by gravity. If any bulbs are caught sideways, they are lifted by the ramps 57 and 58 and prevented from advancing.

An improved means is thus provided for placing bulbs in an upright position and at the exact location desired for transfer to a sealing machine.

The patent contains 10 claims and the following references were cited: 1,311,590, Bingham, July 29, 1919 and 2,609,912, Engel, Sept. 9, 1952.

Sealing of Lamp Bulbs. Fig. 2. Patent No. 2,653,417. Filed September 23, 1952. Issued September 29, 1953. Two sheets of drawings. Assigned to General Electric Company by Conrad E. Bechard and Victor A. Levand, Jr.

The machine comprises a turret or turntable whereof a fragment is shown at 1, (Fig. 2) supporting a series of sealing heads 2 journalled near its periphery. Each sealing head comprises a base 3 which is supported on a

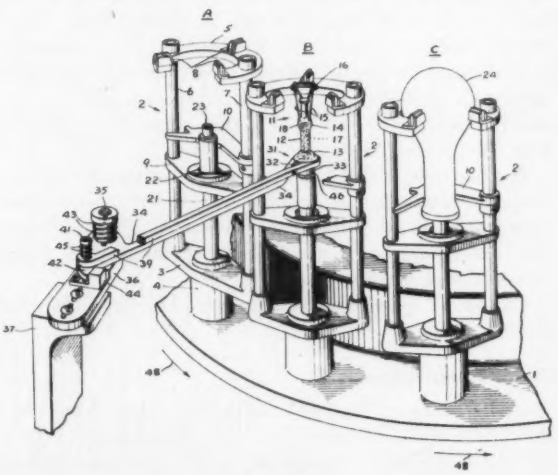


Fig. 2.

hollow shaft journalling at 4 in the turret. A bulb holding frame or yoke 5 is mounted vertically above the base 3 on a pair of side rods 6, 7, the bulb being supported at three points by cushioning jaws 8.

Supported in the sealing head at station B, there is a mount 11 comprising a stem tube 12 formed into a flare 13 at its lower end and into a press 14 at its upper end where the lead wires 15 pass through it to support the filament 16. An exhaust tube 17 projects downward through the center of the stem tube, the juncture being made just below the press. An exhaust port 18 is blown through at the juncture to permit subsequent evacuation of the bulb through the exhaust tube. The mount spindle can be raised or lowered by suitable camming means, such as a track (not shown in the drawing) positioned below the turret and on which the lower end of the spindle rides. The spindle passes through a hole at 22 in member 9 and its upper end terminates in a hollow mount pin 23 into which the lead wires 15 and the exhaust tube 17 of the mount are received.

In the operation of the machine, the mounts are loaded into the spindle of the sealing head at position B. As the sealing head is indexed from position B to C, the spindle rises and the internal jaws grip the exhaust tube and hold the mount securely in place. At station C, a bulb 24 is loaded, either manually or preferably by automatic means, into the yoke 5, in position for sealing of the bulb neck to the flare of the mount.

The patent contains five claims and no references were cited.

Automatic Edge Grinding Machine for Lenses. Patent No. 2,651,890. Filed December 11, 1951. Issued September 15, 1953. Ten sheets of drawings (none reproduced). Robert Rubinstein.

Improvements are made in lens edge beveling machines in order that the lenses will have a more perfect fit in the frames, regardless of the shape of the lens or the number of straight edges commonly found in fancy shaped lenses.

The present invention provides a machine which is unique in its operation for automatically carrying out the finished grinding of a lens blank, regardless of the number of straight edges, in such a manner that the heavy bevel at the straight edges will be at the rear of the lens. Mounting the lens in the spectacle frame will cause the heavy bevel to be located at the rear side of the frame where it will not be noticed. The machine is particularly characterized by its simplicity of set-up and operation making it possible for unskilled help to satisfactorily grind lenses to the desired finished shape to greatly reduce the cost of producing such lenses.

The machine is fully automatic and electrically driven. The improvements may be adapted to older machines and such machines described and illustrated in U. S. Patent No. 1,657,720 granted to Eli M. Long, January 31, 1928, "Lens Edging Machine."

The patent cointains 18 claims and 11 references were given.

Glass Compositions

Manufacture of Sodium Silicate Glasses. Patent No. 2,644,742. Filed February 24, 1950. Issued July 7, 1953. No sheet drawings. Assigned to the Diamond Alkali Company by Robert C. Danison.

The invention relates to improvements in the manufacture of alkali metal silicate glasses, and more particularly relates to improvements in that method of manufacturing sodium silicate glasses, which includes fusing a mixture of silica and a sodium base, such as sodium hydroxide, sodium carbonate or sodium bicarbonate.

Mineral oil is mixed with silica and alkali material prior to subjecting the mix to the fusion temperature (about 2500°F.) of the furnace.

Dusting of the alkali material and loss from the fusion chamber of the furnace is appreciably diminished and the useful life of a furnace unit is substantially increased. A more rapid and more complete fusion of the furnace charge is effected and a superior end product is obtained.

The mineral oil content comprises approximately 0.5-2.5% of the total weight of the mixture and should possess a viscosity of 30 to 100 Saybolt Universal Seconds (S.U.S.) at 100°F.

The patent contains 11 claims and the references cited were as follows: 130,538, Rosenthal, Aug. 13, 1872; 667,222, Ivery, Feb. 5, 1901; 726,091, McKerrow, Apr. 21, 1903; 1,861,711, Moreton, June 7, 1932; 2,284,248, Baker et al., May 26, 1942; 2,345,776, Soderberg, Apr. 4, 1944; 2,390,406, Wegst et al., Dec. 4, 1945; and Merrill: "*Journal of Chemical Education*," v. 24, No. 6, pp. 262-269, June 1947. (Copy in Scientific Library.)

Photosensitively Opacifiable Glass. Patent No. 2,651,145. Filed July 7, 1950. Issued September 8, 1953. One sheet of drawings (none reproduced). Assigned Corning Glass Works by Stanley Donald Stookey.

The batches shown in the table on the opposite page are illustrative of glass compositions falling within the scope of the invention (weight in pounds except the gold solution, which is expressed in cc.).

The above glasses are clear and transparent when melted, worked and cooled, and will so remain when merely reheated. Exposure to short-wave radiations, preferably those between 3000 and 3500 Angstroms, produces an invisible, latent image. This latent image, present only in the exposed portion of the glass, is converted to a visible, opaque image by subsequent heating.

The patent contains 39 claims and the following references were cited: 2,233,622, Lytle, Mar. 4, 1941; 2,281,076, Nash, Apr. 28, 1942; 2,314,804, Willson, Mar. 23, 1943; 2,326,012, Dalton, Aug. 3, 1943; 2,515,943, Stookey, July 18, 1950; and 110,925, Australia, July 11, 1940.

Glass Wool and Fiber

Method of Making Glass Fiber Mats. Fig. 3. Patent No. 2,647,851. Filed February 1, 1952. Issued August 4, 1953. Three sheets of drawings. Assigned to Vibradamp Corporation by Ralph E. Schwartz.

Molten glass 12 is forced by gravity through one or more heated dies 14 in the bottom of vessel 10 which are heated by conventional means (not shown). Primary fibers 16 are pulled downwardly by one or more pairs of opposing feed rollers 18 which feed the primary fibers 16 into position in front of one or more hot gas jets 20 which blow ignited gas substantially horizontally against the primary fibers 16.

Disposed on opposite sides of each of the gas jets 20 is a pair of air jets 22 which blow air under high pressure convergently into the gas stream from said jet 20.

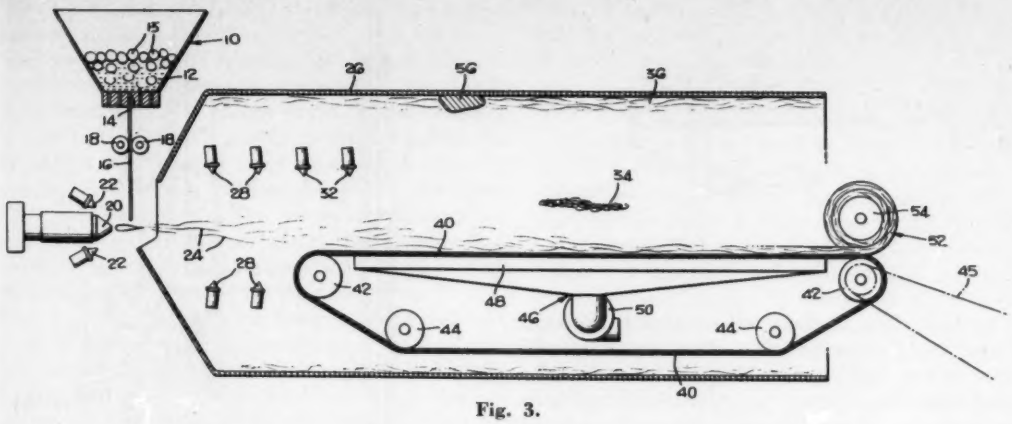


Fig. 3.

This combination of air and burning gas from these jets produces a high-speed movement of hot gaseous matter which strikes the primary glass fibers 16 and splits or shatters each of the primary glass fibers 16 into a multiplicity of secondary glass fibers 24, each of which has a much smaller diameter than the diameter of a primary fiber 16.

A liquid binder solution is sprayed through one or more binder jets 28 into the forming hood 26 while the secondary glass fibers 24 are in the forming hood. The binder solution may include various combinations of the polyesters, such as phenols, vinyls or silicones. Water jets 32 are also provided and the water spray is said to reduce the amount of electrostatic charging on the secondary glass fibers 24 and thus tends to reduce the tendency to "ball" or the entwining of the fibers. The skin or coating of binder is matured by carefully controlling the temperature within the forming hood 26. The complete mat is wound on a spool 54 at the end of the forming hood.

The patent contains one claim and the references cited were as follows: 2,335,102, Bergin et al., Nov. 23, 1943; 2,349,909, Meharg, May 20, 1944; 2,375,182, Anway, May 8, 1945; 2,489,242, Slayter et al., Nov. 22, 1949; and 2,600,843, Bush, June 17, 1952.

Apparatus for Fiberizing Molten Material. Fig. 4. Patent No. 2,646,593. Filed November 4, 1950. Issued July 28, 1953. Two sheets of drawings. Assigned to United States Gysum Company by Richard M. Downey.

An improved method is presented for making slag, glass or mineral wool. The method involves a preliminary centrifugal distribution of the molten material and the propulsion of the material by means of a gaseous blast.

A suitable conducting chute 28 shown in Fig. 4 serves to direct a relatively thin stream 29 of molten glass, slag or the like to a point so located that the stream 29 will be directed to the inner surface 21 of the rotor 18 without touching the shaft 22, the rotor being rapidly rotated at about 700 to 1500 revolutions per minute.

As a result of the dropping of the stream 29 of molten

	1	2	3	4	5	6	7	8	9	10	11	12	13
Sand	267	348	350	348	348	364	350	336	336	364	353	267	350
Na_2CO_3	99	130	133	122	130	138	133	116	56	136	138	99	125
$NaNO_3$	—	—	—	14	—	—	—	—	—	—	—	—	14
K_2CO_3	—	—	—	—	—	—	—	—	62	—	—	—	—
$Al(OH)_3$	60	52	52	52	52	82	52	38	38	82	49	60	52
Borax (anhydrous)	3.3	—	—	—	—	4	—	—	—	4.2	—	—	—
$CaCO_3$	—	—	—	—	13	—	—	—	—	—	9	—	—
ZnO	—	25	25	25	18	—	25	—	—	—	7.5	—	25
$BaCO_3$	—	—	—	—	—	—	—	64	64	—	16	—	—
$AgNO_3$	0.0078	0.01	0.01	0.02	0.02	0.01	0.001	0.01	0.01	0.02	0.03	0.01	—
AgCl	—	—	—	—	—	—	—	—	—	—	—	—	1
Cerium Hydrate (75% CeO_2)	0.05	0.125	0.1	0.125	0.125	0.1	0.1	0.1	0.1	0.15	0.1	0.05	0.1
Sb_2O_3	0.36	0.5	—	0.5	0.5	0.5	0.3	0.5	0.5	0.5	0.5	—	0.3
SnO_2	—	—	0.3	—	—	—	—	—	—	—	—	—	—
25% Gold Soln cc	—	—	—	36	—	—	—	—	—	—	—	—	—
Na_2SiF_6	19	25	19.5	25	25	22	19	22	18	18	22	19	19
NH_4Cl	—	—	—	—	—	—	—	—	—	4	—	—	—
NaCl	—	—	—	—	1	—	—	—	—	—	—	—	—
NaBr	1.3	1.75	1.75	1.75	—	—	1.75	—	1.75	—	1.75	1.3	1.75
KBr	—	—	—	—	—	—	—	1.75	—	—	—	—	—
NaI	—	—	—	—	—	2	—	—	—	—	—	—	—
Corn Starch	—	0.4	0.4	—	0.4	—	0.3	—	—	—	—	—	—

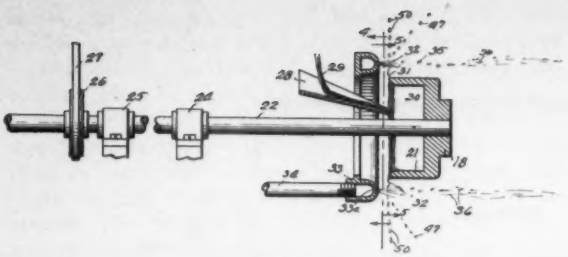


Fig. 4.

slag on to the surface 21, there will be immediately built up an annulus 30 of molten slag. This annulus gradually works its way over the edge 31 of the rotor 18, to be discharged from the periphery under the centrifugal force as an annular mass of small closely adjacent streams 32 of melted slag.

Steam passes out of the annular nozzle 33 under a force of from 70 to 90 pounds per square inch and strikes the small streams 32 of the thus subdivided slag at a point about 1 to 1½ inches from the edge 31 of the rotor 18.

By intercepting the outwardly traveling streams 32 with the annular steam blast, these streams are diverted into a new path, forming horizontally impelled potential fiber-forming particles 35 which, by reason of the high velocity imparted, soon become attenuated into individual fibers 36. The individual fibers are then collected in the form of a mat in a suitable blow chamber.

The patent contains 20 claims and the following references were cited: 1,601,897, Wiley et al., Oct. 5, 1926; 2,318,244, McClure, May 4, 1943; 2,328,714, Drill et al., Sept. 7, 1943; and 2,497,369, Peyches, Feb. 14, 1950.

Sheet and Plate Glass

Mirror Glass. Patent No. 2,647,068. Filed March 16, 1948. Issued July 28, 1953. No drawings. Imre Patia; H. Russell Bishop, administrator of the estate of Imre Patai, deceased.

A bath of molten silver nitrate was prepared by heating the silver nitrate in a container over a flame until it acquired an internal temperature of 212°C. to 300°C. A piece of soft soda-glass, the so-called non-corrosive commercial type, was immersed in this bath from 3 to 10 minutes at a temperature of 220°C. The chemical characteristic of the glass resulting from the foregoing diffusion step probably is expressed by the formula:

$$Na_2SiO_4 + 2AgNo_3 = Ag_2SiO_4 + 2NaNO_3$$

The glass was removed from the bath, cooled and then washed thoroughly with a solution of nitric acid and distilled water to remove the excess substance. The glass piece was then heated in a reducing atmosphere at 400°C. to 700°C., preferably at 600°C. The result was a uniform, highly reflective metallic layer, completely embedded in the glass matrix and occupying a thin stratum immediately beneath the adjacent surface, the chemical characteristic of the glass then probably being expressed by the following formula:

$$Ag_2SiO_4 + 2H_2 = 2H_2O + 2Ag + SiO_2$$

By using mixed silver salts 80% silver nitrate, 20% potassium nitrate and lower temperatures than the melting point of the silver nitrate alone, the diffusing step required more time, but the metallic layer produced by the step of reduction is very clean and perfect.

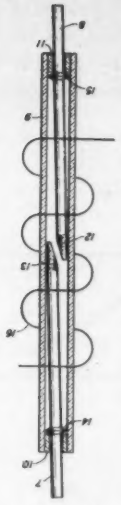


Fig. 5.

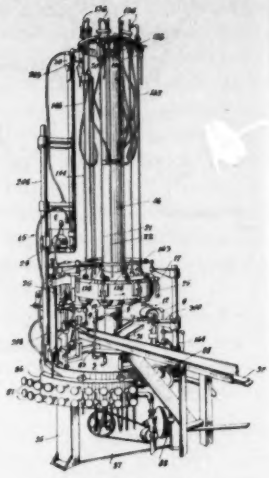


Fig. 6.

The resulting metallic mirror is said to be highly resistant to mechanical or chemical injury because the mirror surface is completely embedded in the glass.

The patent contains five claims and 18 references were cited.

Tube and Cane Machines

Sealing Glass Electrodes. Fig. 5. Patent No. 2,648,167. Filed December 18, 1948. Issued August 11, 1953. Two sheets of drawings. Assigned to Bell Telephone Laboratories, Incorporated by Walter B. Ellwood.

The temperature used in sealing switch electrodes to the glass envelop is reduced considerably by employing a sealing glass of low fusion temperature and improved assembly process. Each switch is assembled as shown in Fig. 5. Two electrodes 7 and 8 are placed in a glass envelop 9. The beveled surfaces of electrodes 7 and 8 are forced against one another so as to make contact with tips 12 and 13. These tips are plated with rhodium to assure a hard, long wearing, low-resistance surface. Annular glass seals such as 10 and 11 are inserted through the projecting extremities of the electrode until they rest on the upset flanges.

The gap between the two beveled contact surfaces is accurately and uniformly determined by the amount of thermal expansion of an element in a temperature responsive jig which holds the switches while the electrodes are spaced and the switch envelope is sealed in a furnace. A belt guide is used to carry a series of these switch holding jigs into a temperature controlled furnace where the spacing and sealing steps occur.

The details of the jigs and the sealing operation are shown in the various drawings accompanying the patent. The patent contains 10 claims and the following references were cited: 2,264,746, Ellwood, Dec. 2, 1941; 2,279,168, Kallischer et al., Apr. 7, 1942; 2,332,338, Peek, Oct. 19, 1943; 2,392,099, Pollard, Jan. 1, 1946; 2,406,008, Ellwood et al., Aug. 20, 1946; 2,406,021, Little, Aug. 20, 1946; and 2,486,101, Beggs, Oct. 25, 1949.

Machine for Forming ampuls. Fig. 6. Patent No. 2,469,659. Filed January 2, 1951. Issued August 25, 1953.

Nine sheets of drawings. Assigned to Kahle Engineering Company by Louis C. Kahle.

In the operation of the machine, as shown in Fig. 6, the turret rotates intermittently and presents the chucks with their lengths of glass tubing to the different stations on the stationary underlying table 3. At one station the chucks present the tubing to a cutting-off mechanism 12. When severed, the lower portion drops onto the guide chute 31 and is directed to the conveyor 32, which removes it to a box or other container. The lower end of the length of tubing, which remains in a chuck, is correctly positioned for forming by the mold halves.

Before reaching the forming station, the chucks are presented to a number of heating stations. At the forming station, the mold halves come together about the lower portion of the glass tubing and the chuck jaws are opened by the cam 26 actuating the operating arm 25. After reforming the lower end of the tubing, the turret is indexed another step for further forming operations. The details of the machine are evident by a complete study of the detailed drawings.

The patent contains 24 claims and the following references were cited: 1,165,884, La France, Dec. 28, 1915; 1,262,567, Rippl, Apr. 9, 1918; 1,330,707, Hoffstetter et al., Feb. 10, 1920; 1,342,821, Leiman, June 8, 1920; 1,532,077, Quackenbush et al., Mar. 31, 1925; 1,546,353, Rippl et al., July 14, 1925; and 1,587,466, Brown et al., June 1, 1926.

Apparatus for Bending Tubular Lamps. Patent No. 2,649,660. Filed August 14, 1951. Issued August 25, 1953. Two sheets of drawings (none reproduced). Assigned to General Electric Company by Joseph F. Ochwat.

An improved lamp bending apparatus is shown wherein the lamp is heated and bent during the course of the passage through a succession of work stations. The patent is an improvement of the apparatus disclosed in Patent No. 2,494,923, Yoder et al., dated January 17, 1950.

Heretofore both the manner and speed of operation of the bending apparatus have been restricted by the necessity of effecting the final heating step, the bending step and a cooling step at one work station, since each of these steps must follow one after the other without interruption.

The above operations are carried out with considerable saving in time by means of movable control elements and a movable oven that oscillates between two successive work stations on the apparatus.

The patent contains seven claims and the references cited were as follows: 1,949,901, Cosh, Mar. 6, 1934; 2,110,327, Dichter, Mar. 8, 1938; 2,270,152, Themak, Jan. 13, 1942; 2,494,872, Greiner et al., Jan. 17, 1950; and 852,138, France, Jan. 24, 1940.

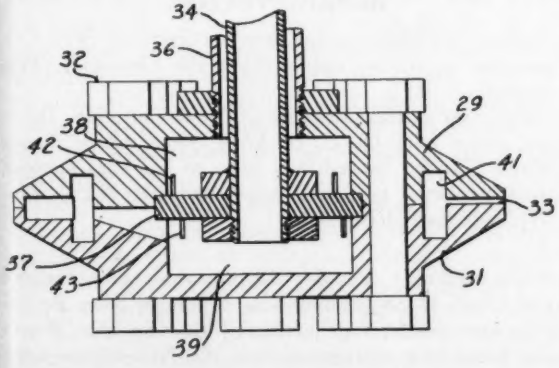


Fig. 7.

Miscellaneous Processes

Apparatus for Glass-to-Metal Seals. Fig. 7. Patent No. 2,648,166. Filed March 6, 1950. Issued August 11, 1953. Three sheets of drawings. Assigned to the Collins Radio Company by Floyd A. Fisher and Walter H. Kohl.

In joining glass to metal or ceramic bodies in the tube industry, a lathe is commonly employed and heat applied by an internal burner. A feature of the invention is to provide a suitable burner with a plurality of openings about its periphery and thus apply heat to the internal surfaces of the objects to be joined.

Figure 7 illustrates a tube with its inner conductor 34 and its outer conductor 36 in their relative spatial relationship for supplying fuel gas and oxygen to the burner. The internal portion of the discs 29 and 31 are hollowed out and a partition 37 is received between them to divide the space formed into two chambers 38 and 39. The internal conductor 34 extends through the chamber 38, the partition 37 and emerges in the chamber 39. The outer conductor 36 opens into the chamber 38. Thus, if oxygen is supplied to the outer conductor 36, the chamber 38 will contain oxygen, and if fuel gas is furnished to the inner conductor 34, it will be supplied to the chamber 39. An annular opening 41 is formed between the discs 29 and 31 adjacent the outer edges when the discs are assembled. Openings 42 connect the chamber 38 with the annular opening 41 to allow oxygen to arrive and openings 43 extend the chamber 39 to the annular opening 41 to furnish fuel gas. At various points about the periphery of the burner are formed outlets 33 through which the mixed gas emerges. It is ignited as it leaves the burner and continues to burn as long as the fuel supply is left on.

When the glass is heated sufficiently, it becomes plastic and makes the seal. The burner is then burned off and the work is allowed to cool before being removed from the lathe.

The patent contains two claims and the references cited were as follows: 1,323,485, Mueller, Dec. 2, 1919; 1,373,565, Kunitz, Apr. 5, 1921; 1,741,662, Schoonenberg, Dec. 31, 1929; and 961,324, France, Nov. 21, 1949.

ACHESON APPOINTS NEW SERVICE ENGINEER

Alden Crankshaw, Sales Manager of the Acheson Colloids Company, Division of Acheson Industries, Inc., has announced the appointment of O. W. Mendenhall as service engineer, with headquarters in Milwaukee, Wisconsin. Besides the entire state of Wisconsin, Mr. Mendenhall will serve the Minneapolis-St. Paul area. His activities will be directed by E. R. Hays, Acheson's territorial supervisor who had previously serviced these areas and whose office is in Chicago.

Mr. Mendenhall received his B.S. degree in chemistry in 1940 from Sterling College and held a teaching fellowship in the University of Kansas in 1941 and 1942. He came to Acheson from the Miller Brewing Company, where he was Senior Chemist and had worked previously for the Milwaukee Gas Specialty Company and the Chrysler Corporation.

GLASS FIBERS BURBANK PLANT DESTROYED BY FLASH FIRE

A flash fire, fed by volatile chemicals, destroyed the structure, manufacturing equipment and raw material inventory at the Burbank, California, plant and offices of Glass Fibers, Inc. Officials at the home office in Toledo have momentarily estimated the damage at less than a quarter million dollars.

The plant housed general offices for the company's Western Division and offices and manufacturing facilities for its Aero-Coustic Division. According to M. D. Worcester, Vice President of Glass Fibers and General Manager of the Western Division, the fire originated with a static electricity spark caused by low humidity and hot weather conditions. The spark traveled along a laminating conveyor line, ignited volatile adhesive materials in a spray booth and spread to the roof structure.

Company officials said that building, equipment and inventories are covered by insurance. They expect to rebuild the present facilities as quickly as possible.

BALL BROS. PURCHASES BABY BOTTLE BUSINESS

Ball Brothers Company has announced the purchase of the Hygeia baby bottle business and the broadening of the Ball line of consumer products to serve the drug industry.

The Hygeia business was purchased from The Hygeia Nursing Bottle Company, Inc., of Buffalo, New York, with all transfers effective at the close of business on October 31. Acquisition of the Hygeia business, the third major expansion the Ball company has made in the last six months, coincided with the announcement that the company has formed a separate organization to serve the drug trades. This new sales and distribution organization, according to Duncan C. Menzies, Executive Vice President and General Manager, will function within the Ball Consumer Products Division, headed by William E. Palmer, Manager.

OWENS-CORNING EXPORT MANAGER NAMED

The appointment of George Cook, III, as Manager of the Export Division of Owens-Corning Fiberglas Corporation has been announced by E. W. Smith, Vice President of the sales branch operations.

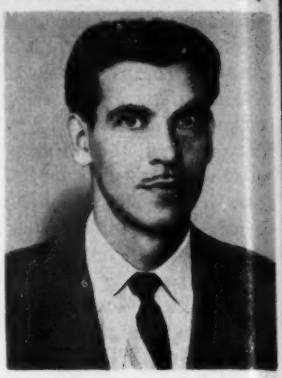
Mr. Cook joined Owens-Corning in 1948 as a sales trainee after graduation from Yale University, and subsequently served as a salesman in Baltimore and New York City. In January of this year, he was placed in charge of the corporation's recruiting program with headquarters in Toledo.

DIRECTOR ELECTED TO L-O-F BOARD

V. K. Forsyth, Vice President of the Solvay-American Corporation of New York, has been elected a Director of Libbey-Owens-Ford Glass Company at the recent meeting of the Board of Directors. He succeeds F. E. Notebaert of Canada who retired in August after 26 years' service on the L-O-F directorate.

Mr. Forsyth joined Solvay-American in 1927 after serving as Assistant Manager of the Bank of Nova Scotia, having begun his business career with that bank upon leaving school.

WALL COLMONOY NAMES SALES MANAGER



The appointment of Elmer J. Lell as Sales Manager for Wall Colmonoy Corporation has been announced by William P. Clark, Vice President.

Mr. Lell joined Wall Colmonoy in 1948 as Midwest Sales Engineer. He was named Branch Manager of the Company's Houston, Texas office in 1950. He returned to the home office in Detroit in 1951 and served successively as Sales Engineer and Assistant Sales Manager, prior to his new appointment.

Mr. Lell studied mechanical engineering at UCLA and spent several years in the heat treating, materials handling and steel erection industries before joining the company.

PROGRAM FOR CONFERENCE ON GLASS PROBLEMS

The Fourteenth Conference on Glass Problems, scheduled to be held at the University of Illinois on December 3 and 4, will include the following topics and speakers: *Glass and Batch Control:* James P. Poole, Brockway Glass Company; Fred R. Motsch, Foster-Forbes Glass Company; and Howard R. Lillie, Corning Glass Works. *Refractories Application:* J. A. Johnson, Findlay Clay Products Company; R. W. Knauft, Chas. Taylor Sons Company; S. M. Swain, North American Refractories Company; W. F. Rochow, Harbison-Walker Refractories Company; H. W. Baque, Corhart Refractories Company; and O'Mara White, The Carborundum Company. *Raw Materials:* Wm. J. Woods, Jr., Pennsylvania Glass Sand Corp.; Louis G. Love, National Lime and Stone Company; M. H. Pickard, Pacific Coast Borax Company; H. W. Harrington, Solvay Process Division, Allied Chemical & Dye Corp. *Packaging and Shipping of Glassware:* Richard O. Spalding, Owens-Illinois Glass Company; Henry E. Walker, Harding Glass Company; and John Turk, Preston Laboratories and Glass Container Manufacturers Institute.

SELAS NAMES REPRESENTATIVE

Thurman G. Thurston has been appointed by Selas Corporation as its representative in the Cleveland, Ohio, territory.

Educated at Case Institute of Technology, Mr. Thurston served with the U. S. Army Signal Corps during World War II. Immediately prior to his Selas appointment, he served as a development and sales engineer for Bryant Industrial Division.

• The Richard C. Remmey Son Company has announced that Frank C. Shaner has been appointed Sales Service Representative for the Cleveland, Ohio, area. Mr. Shaner was formerly a representative in the Philadelphia territory.

A Study of the Reaction Rates Between Silica and Other Oxides at Various Temperatures, Parts I and II

The rate of reaction between silica and other oxides, notably the alkalis and the alkaline earths, are of importance in industry since they determine the rates at which glass can be produced commercially. They also present problems of fundamental interest, though of some complexity.

Various methods have been tried by previous workers to compare the rate of reaction in binary mixtures of silica with different metallic oxides and also in ternary mixtures of silica with pairs of metallic oxides. In the June 1953 issue of the *Journal of the Society of Glass Technology*, Abd-El-Moneim Abon-El-Azm and H. Moore report on the results of the X-ray diffraction technique for investigation of this type.

The rates of reactions between silica and a number of the more important oxides used in glass manufacture were studied by estimating the amount of crystalline silica left after mixtures containing known proportions of quartz and one of the other oxides had been heated for various periods at different temperatures. The mixtures were made up in amounts of 50 gm. in all cases and were fired in platinum crucibles in electric furnaces.

The amounts of crystalline silica in the fired mixtures were determined by measuring the intensities of prominent lines of quartz, tridymite and cristobalite in the X-ray diffraction spectra given by the fired mixtures (a) alone and (b) with 50 per cent of added quartz, tridymite or cristobalite. The ratios of the intensities of these lines were then compared with the ratios of the intensities of the same lines in the diffraction spectra given by mixtures containing known proportions of quartz, tridymite and cristobalite. From these observations, the amounts of crystalline silica present in the fired mixtures were then calculated. The maximum error in the amount of silica obtained in this way was estimated by observations made on a number of mixtures containing quartz, tridymite and cristobalite in known proportions, mixed with other materials, including glass, in known amounts. These observations showed that the maximum error in estimating the total amount of uncombined silica would not exceed $\pm$ 12 per cent and would usually be not greater than $\pm$ 6 per cent of the amount of uncombined silica remaining in the fired mixture. Unless, therefore, the reaction had been only slight, the extent of the reaction could be determined to well within $\pm$ 6 per cent and to within much smaller limits as the reaction approached completion.

The rate of reaction between silica and other oxides at any particular temperature must obviously depend on various factors such as (a) area of the silica grains or crystals in contact with the other oxide; (b) the extent to which the products of the reaction are removed as they are formed from the surface of the silica, depending on the rate of diffusion of the reaction product through the heated mass which will obviously be greater if the product is fluid than if it is solid; (c) the activation energy of silica and of the other oxide; (d) the energy of combination of silica with the other oxide; (e) the extent to which dissociation of the reaction product occurs, or the association-dissociation equilibrium of the reaction product at the temperature of firing.

The theoretical consideration of the rate of reaction on the basis of the factors enumerated above presents difficulties which can, however, be reduced in number by eliminating certain of the variables which have been present in the experimental work described. A future paper will deal with these aspects.

It was interesting to note that in all cases, except those containing small or large proportions of the alkalis, the extent of the reaction appears to approach some limiting value as the duration of heating is increased, the limiting value being dependent on the firing temperature.

In comparing the observations made on the silica-soda and silica-potash mixtures, it was shown that at all temperatures the reaction occurs less rapidly with soda than with the molecular equivalent of potash. The greater mobility of the sodium ions, the differences between the activation energies of sodium and potassium, and the greater energy of combination of soda and silica as compared with potash and silica would have suggested that the reaction rates of silica with soda would be more rapid than with potash. The results can, however, be understood when it is recalled that the chance of potassium ion escaping from the silica network is very much less than the chance of escape of a sodium ion. When, therefore, reaction has occurred between the potash and the silica, the chance of dissociation, with the possible formation of cristobalite or tridymite, will be considerably less than the chance of dissociation of a similar silica-soda reaction product.

The results show that the reactions in mixtures of silica with boric oxide occur at only about half the rate of reaction in mixtures containing corresponding proportions, by weight, of silica and soda.

Reactions occur to a measurable extent at temperatures of 1200°C. and higher in silica-lime and silica-magnesia mixtures. At 1400°C. some 25 per cent of the silica enters into combination during 48 hours in a mixture containing lime or magnesia equivalent to 25 per cent Na_2O.

It was not possible to obtain any definite evidence of reaction between silica and calcined alumina at any temperature up to 1400°C. owing to the impossibility of distinguishing between the lines of approximately 3.35 A. given by quartz, mullite and corundum.

In ternary mixtures containing equivalent proportions of Na_2O and K_2O, the rates of reaction in the potash mixtures are more rapid than in the soda mixtures at temperatures exceeding 900°C., though the differences are small or in the reverse order at 900°.

The addition of small amounts of lime or magnesia to binary mixtures of silica and soda or silica and potash increases considerably the rates of reaction.

The rates of reaction in ternary mixtures in which

(*Continued on page* 636)

G.C.M.I. FALL MEETING

The Board of Trustees of the Glass Container Manufacturers Institute has announced the 1953 Fall Meeting to be held December 1, 2 and 3 at the Lago Mar Hotel in Fort Lauderdale, Florida.

The purpose of the meetings will be to provide an opportunity for the Board of Trustees to receive semi-annual reports from the standing committees, to make the same available to the membership and to hold the semi-annual membership meeting.

Aside from the business activity, a men's golf tournament will be held and a luncheon-Bridge-Canasta party is planned for the ladies. Obear-Nester Glass Company will be host to members and guests at a cocktail party on December 1 and the G.C.M.I. cocktail party and dinner is scheduled for December 2.

HOUZE NAMES INDUSTRIAL RELATIONS DIRECTOR

Harry D. McLaughlin, formerly Supervisor of Industrial Relations of Westinghouse Electric Corporation, Tube Division, and Corning Glass Works, has been appointed to the newly-created post of Director of Industrial Relations at the L. J. Houze Convex Glass Company, according to an announcement by E. V. Ogg, Executive Vice President.

As Supervisor of Industrial Relations at Westinghouse, Mr. McLaughlin was responsible for many services, including training, employment and employee activities. In 1934 he began his career with Corning Glass Works as a shop laborer, working his way up to the post which he last held when he joined Houze.

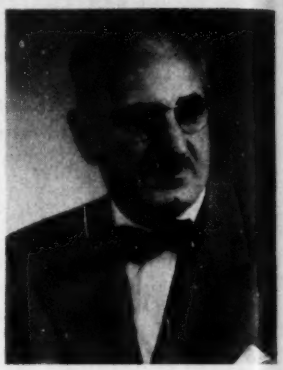
L-O-F- SELLS PLASKON DIVISION TO ALLIED CHEMICAL

Sale of the business and assets of its Plaskon Division to the Allied Chemical & Dye Corporation on a mutually advantageous basis has been announced by John D. Biggers, Chairman of the Libbey-Owens-Ford Glass Company. The transfer of Plaskon as an operating unit became effective October 1, 1953.

Libbey-Owens-Ford purchased the assets of Plaskon in 1943 and since that time has operated it as a division of the glass company. In those ten years, the number of employees has more than doubled, and the present value of plants and equipment is 17 times the value of the properties originally acquired by L-O-F. New products have been developed, enabling Plaskon to serve several new markets and to increase the number of customers substantially.

Plaskon will now have an ideal affiliation in the chemical industry since Allied produces basic chemicals needed by Plaskon in its manufacturing. Products presently manufactured by Plaskon are used in plastic moldings, protective coatings and for many other industrial and military purposes.

HAROLD BAQUE ELECTED CORHART VICE PRESIDENT



The Corhart Refractories Company has announced that Harold W. Baque has been elected a Vice President of the company.

Mr. Baque, an engineering graduate of Ohio State University, has been with the Corhart company since 1930 and is widely known throughout the glass manufacturing industry both in engineering and in sales capacities.

PROMOTIONS AT WHEATON

Announcement has been made by the management of the Wheaton companies of new assignments in their sales organization.

In the T. C. Wheaton Company, Ralph B. Wentzel has been named to the newly-created post of Vice President in charge of Sales. He will be responsible for the sale of all Wheaton glass products. Mr. Wentzel formerly served as Sales Manager of the Drug and Chemical Container Division and as assistant to Frank H. Wheaton, President of the company.

Herbert H. Mills, former Sales Manager of the Cosmetic Container Division, has been promoted to a vice presidency. In this capacity, Mr. Mills will serve as a special assistant to President Wheaton.

Succeeding Mr. Wentzel is Walter F. Gavigan, who joined the company as an accountant and more recently served as Sales Manager of the Tubing and Tubing Products Division. The sales functions of the latter division have been absorbed by the Drug and Chemical Container Division so that Mr. Gavigan continues to direct the sale of tubing and tubing products.

Roberts M. Roemer, successor to Mr. Mills, has returned to the Wheaton home offices in Millville, New Jersey, from his former post as sales representative in the company's Chicago office.

CHAS. TAYLOR APPOINTS REPRESENTATIVE

The Chas. Taylor Sons Company, a subsidiary of National Lead Company, has announced the appointment of Floryan J. Tokar as their exclusive representative for northern and central Illinois, northern Indiana, Wisconsin and eastern Iowa.

Mr. Tokar is a graduate of Lehigh University where he received his B.S. in Mining Engineering. Mr. Tokar was for several years with Bethlehem Steel Company and U. S. Steel. After service in the U. S. Army Ordnance Department, he has been employed by the General Refractories Company, Standard Steel Works of Baldwin-Lima-Hamilton Corp. and the Quigley Company.

• The special studies of five Alfred University students, now graduated, at the State College of Ceramics on "The Resin Bonding of Aluminum Oxide with Special Reference to Its Use in Grinding Wheels" is soon to be published by the Exolon Company.

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during August 1953 was as follows: *Flat Glass:* A preliminary 31,500 persons employed, compared with an adjusted 31,200 persons employed during July, or an increase of .9 per cent. *Glass and Glassware, Pressed and Blown:* An increase of 3.8 per cent is shown for August with a preliminary employment figure of 89,600 persons, compared with July's adjusted 86,300 persons. *Glass Products Made of Purchased Glass:* August employment was a preliminary 14,100, which is the same as the adjusted July figure.

Payrolls in the glass industry were: *Flat Glass:* A preliminary $12,821,445 reported for August, which is .2 per cent below the adjusted July payrolls of $12,849,408. *Glass and Glassware, Pressed and Blown:* A preliminary August figure of $26,492,635 is reported, which is 5.8 per cent higher than the adjusted $25,022,110 reported for July. *Glass Products Made of Purchased Glass:* An increase of 6.8 per cent is shown for August with a preliminary $3,737,894, as compared with July's adjusted figure of $3,496,753.

GLASS CONTAINER SHIPMENTS
(All Figures in Gross)

	September, 1953
Narrow Neck Containers	
Foods	1,649,101
Medicinal & Health Supplies	1,024,427
Chemicals, Household & Industrial	745,047
Beverages, Returnable	361,414
Beverages, Non-returnable	78,459
Beer, Returnable	199,451
Beer, Non-returnable	904,346
Liquors	797,406
Wines	300,363
Toiletries & Cosmetics	599,129
Sub-total (Narrow)	6,659,143
Wide Mouth Containers	
Foods	*2,815,849
Dairy Products	325,257
Medicinal & Health Supplies	331,995
Chemicals, Household & Industrial	150,418
Toiletries & Cosmetics	120,970
Packers' Tumblers	168,045
Sub-total (Wide)	3,912,534
Total Domestic	10,571,677
Export Shipments	231,525
TOTAL SHIPMENTS	10,803,202

* This figure includes Home Canning.

GLASS CONTAINER PRODUCTION AND INVENTORY
(All Figures in Gross)

		Production September 1953	Stocks September 1953
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	3,715,474	3,647,385
	Wide Mouth	*3,366,871	*3,538,735
Dairy Products		298,346	279,645
Beverages, Returnable		440,617	901,253
Beverages, Non-returnable		91,819	119,767
Beer, Returnable		231,465	186,722
Beer, Non-returnable		800,395	502,076
Liquors		800,472	857,011
Wines		302,676	318,393
Packers' Tumblers		166,023	175,973
TOTAL		10,214,158	10,526,960

* This figure includes Home Canning.

Glass container production, based on figures released by the Bureau of Census, dropped 11 per cent during September 1953 to reach 10,214,158 gross. This is a decrease from August production of 11,488,766 gross. During September 1952, production of glass containers was 10,100,435 gross, which is 1.1 per cent below September this year. Total glass container production at the end of the third-quarter of 1953 is 93,421,772 gross, which is 6.4 per cent higher than the 87,788,753 gross produced during the corresponding period ending September 1952.

Shipments of glass containers during September 1953 fell off slightly to reach 10,803,202 gross. This is only .5 per cent less than the 10,866,716 gross shipped during August. During September 1952, glass container shipments were 9,888,669 gross, which is 9.2 per cent less than for September 1953. At the close of the nine-month period of 1953, glass container manufacturers have shipped a total of 92,171,302 gross. This is 5.8 per cent above the 87,107,579 gross shipped during the same 1952 period.

Stocks on hand at the end of September 1953 were 10,526,960 gross. This is 5.9 per cent less than the 11,193,082 gross on hand at the end of August and 9.7 per cent higher than the 9,594,477 gross on hand at the end of September 1952.

Automatic tumbler production during the month of August 1953 jumped sharply and was 5,704,610 dozens. This is 47.7 per cent above the 3,861,007 dozens produced during July. Production during August 1952 was 5,832,795 dozens. Shipments also rose and were reported to be 5,388,554 dozens. This is 9.2 per cent above the 4,930,961 dozens shipped during July. Shipments during August 1952 were 5,181,290 dozens. Stocks on hand at the end of August 1953 were 10,107,240 dozens, which is 1.5 per cent higher than the 9,952,927 dozens on hand at the end of July. Stocks at the end of August 1952 were 8,627,981 dozens.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware during August 1953 were 3,252,413 dozens. This is an increase of 18.7 per cent over the 2,739,148 dozens sold during July. Sales during August 1952 were 3,353,538 dozens. At the close of the 12-month period ending August 1953, manufacturers had sold a total of 41,432,840 dozens. This figure indicates that August 1953 sales are 6.7 per cent ahead of the 38,801,317 dozens sold during the same period in 1952.

New Equipment and Supplies

SPRAY GUN AVAILABLE

The O. Hommel Company, Pittsburgh, Pa., has announced that its standard model spray gun is again available.

Used for fine blending or dying out effect in luster, glass colors, under or overglaze colors, the spray gun's color tube is continuous from the bottom of the jar to the fluid or spray tip. Tips or nozzles of different sizes are interchangeable.

GLASS CLEANING MACHINE

Henry G. Lange Machine Works, Inc., 166 N. May Street, Chicago 7, Illinois, has announced a machine that cleans both sides of a glass surface simultaneously, removes water marks, dirt, slime, etc., and polishes the surface at the rate of approximately 20 feet per minute. Speed of cleaning may be increased by adding additional brushing units. No washing or compressed air for drying is required.

The machine shown is arranged for cleaning glass from 2" to 18" in width and 13" or longer in length, and can be furnished for wider glass if desired. Brush spindles are ball bearings. Brushes are wood cored, split brush type, and are available in any width desired and are 6½" in diameter. They are held in place by friction cups and are quickly and easily changed when a different brush is required. An adjustable friction guide and chain drive with rubber rollers on which the glass travels keeps the glass moving at a fast, even rate of speed.

The machine is furnished with 4 pair of brushes, 4 only ½ H.P., A.C., 1750 RPM ball bearing motors driving the brushes and a ½ H.P., 1750 RPM ball bearing motor driving the speed reducer which in turn drives the chain and sprockets moving the glass between the brushes. A 48" long loading and unloading bracket is placed at each end of the machine, arranged with automatic feed so that the glass is fed into and out of the machine at the same speed at which it travels between the brushes.

REINFORCED ABRASIVE BLADES

Robert G. Evans Company, 6315 Brookside Plaza, Kansas City 13, Missouri, has announced entirely new reinforced abrasive blades for use on masonry saws. They are being marketed under the trade name Target "Safety-Blades."

The new blade will readily take severe flexing, side pressures and bumping while in operation, according to the company's release. It is the result of an entirely new process which molds a strong center core of strongly woven synthetic fabric.

VARIABLE SPEED DRIVES

Link-Belt Company, 307 N. Michigan Avenue, Chicago 1, Illinois, has announced two new types of its P.I.V. positive, infinitely variable speed drives for 20 to 25 horsepower applications.

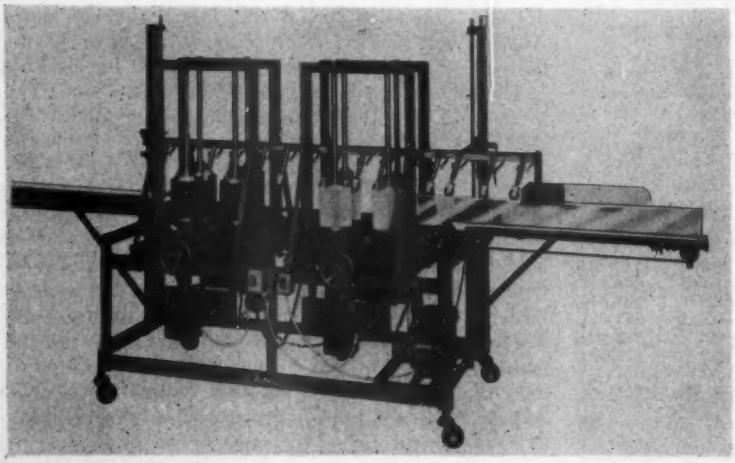
Now available is a HG-6 drive, furnished with either a single reduction input or single reduction output helical gear attachment, or a HGG-6 drive, furnished with both a single reduction input and single reduction output helical gear attachment. Input gear reductions are available from 1.93:1 minimum to 5.82:1 maximum, and output gear reductions from 1:1 to 6.33:1. Speed increasing gear sets are also available.

REDESIGNED RECORDING SPECTROPHOTOMETER

General Electric Company, Special Products Section, Schenectady 5, New York, has announced a redesigned recording spectrophotometer for industrial use in setting up standards to control the color of glass, paints, dyes, textiles and other materials.

According to company engineers, the instrument now furnishes a rapid color analysis by drawing a complete didymium curve in 54 seconds with photometric accuracy of 0.5 per cent, wavelength accuracy within 1.0 millimicron and photometric precision within 0.2 per cent. A range of 380 to 700 millimicrons has been provided in anticipation of any new colorimetric standards which may be established by the International Commission of Illumination.

A new feature is the use of a small lucite cylinder so that light is passed directly to the phototube, thereby increasing the total light available. A new electronic system employs only hard tubes and eliminates the need for thyratron tubes.



CATALOGS RECEIVED

Kaiser Aluminum & Chemical Sales, Inc., Chemical Division, 1924 Broadway, Oakland 12, California, has issued an instructional brochure, "Basic Hot-Zones for Cement Kilns," covering the installation of refractory brick in cement kilns.

Pointing out that the use of basic brick to line the hot-zones is a relatively new technological advancement, the brochure draws on experience gained from installations made throughout the nation and abroad. A pocket-sized publication, it contains 30 pages of text and illustrations.

Sommer & Maca Glass Machinery Company, 3600 South Oakley Avenue, Chicago 9, Illinois, has announced a new glass machinery catalog containing 100 pages and over 150 illustrations of a complete line of glassworking machinery designed and engineered for the flat glass trade. Many newly developed machines are illustrated and described for the first time.

The Hays Corporation, Michigan City, Indiana, has released an 8-page booklet on the new Hays Diaflow Meter which gives data on the meter for measuring air flow, gas flow and the ratio of air flow to gas flow.

Norton Company, Worcester 6, Mass., has announced complete revision of its booklet, "Norton Cut-Off Wheels." While this is a revision, the company reports that it contains much information which is completely new.

The 36-page instructive manual gives information on various types of cutting-off machines and abrasive cut-off wheels, their selection, application and proper usage, in addition to photographs of typical cutting-off operations and various helpful tables for wheel selection and wheel speed conversion.

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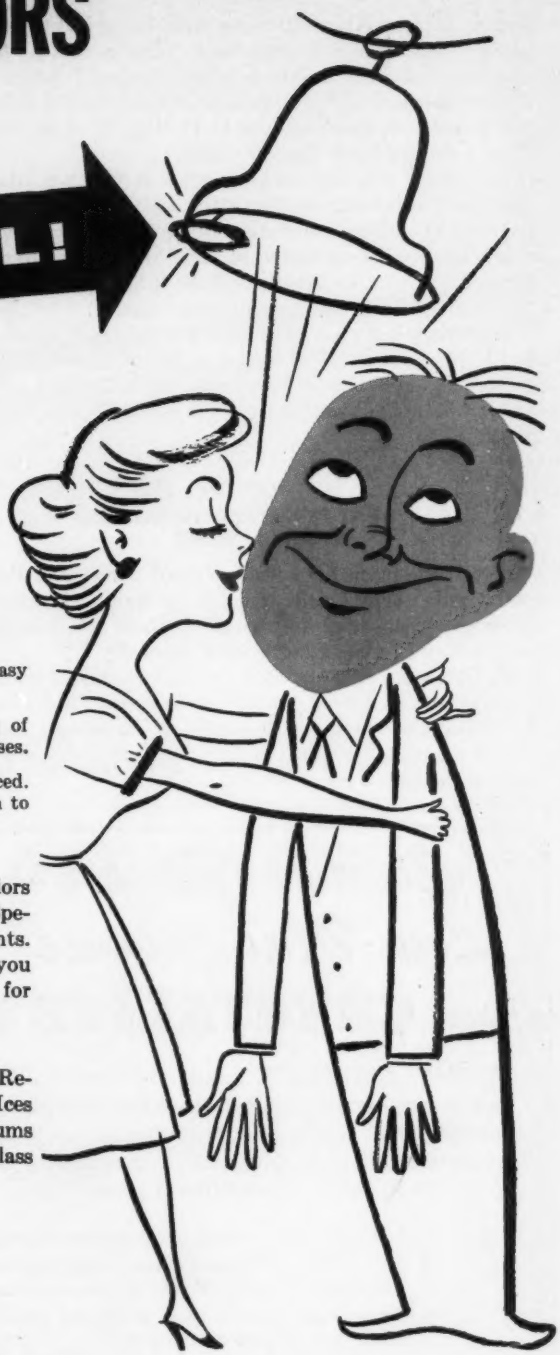

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Phone: HEmlock 1-8800

L-O-F APPOINTMENT

George L. Smead, for 20 years with Libby-Owens-Ford Glass Company and a specialist in plastics for the last five years, has been transferred from Plaskon Division to become Manager of Sales to the reinforced plastics industry, it has been announced by C. F. Hegg, General Sales Manager of the Fiber Glass Division.

Mr. Smead will work closely with Don W. Lyon, Manager for textile sales of fiber glass, and also with manufacturers of polyester and other resins used in producing fiber glass reinforced materials. Mr. Smead has already had a large part in introducing the firm's Garan finish to textile operators and plastics laminators.

Beginning his glass career in the Rossford plant of L-O-F, Mr. Smead later worked in production of safety glass, joining the New York sales office in 1944. His offices will be in Toledo at the Fiber Glass Division headquarters.

STAUFFER CHEMICAL APPOINTMENT

Arthur H. Swanson has been appointed Director of Purchases and General Credit Manager for Stauffer Chemical Company, it has been announced by Hans Stauffer, Executive Vice President and General Manager.

Mr. Swanson, who has been associated with the Stauffer organization for 22 years, was formerly Purchasing Agent and General Credit Manager for the eastern division of the company. He will continue to make his headquarters in New York.

NORTON STAFF CHANGES

W. Alexander McCune, Jr. has been appointed General Sales Manager of Norton Company of Canada, Ltd. A former abrasive engineer in the northern New Jersey area, Mr. McCune succeeds C. W. Fell, who will become an abrasive engineer in the Toronto area. Ill health has forced Mr. Fell to take a less strenuous part on the company's sales program.

Winton A. Vagedes has been appointed an abrasive engineer and will assume Mr. McCune's former territory. He is a former department manager and abrasive specialist at the C. W. Marwedel Company, a Norton distributor. He is presently completing a Norton training course.

Mr. McCune has been with Norton since 1940 except for two years during the War when he served as a Naval officer aboard a destroyer escort.

DIAMOND ALKALI ADDS TO SALES STAFF

Frank Grilli, whose entire career has been devoted to chemical sales work, has joined the New York branch sales office staff of Diamond Alkali Company, according to an announcement by H. B. Clark, Branch Manager.

Active for many years with Innis, Speiden & Company, Mr. Grilli was most recently Manager of their resale chemical department. To his new post with Diamond, he brings not only a diversified background in chemical sales administration, but also a business and chemical education. He attended Pratt Institute, completing the three-year chemistry course.

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REMMEY CRYSTALITE (mullite-bonded mullite) is produced in all shapes necessary to make up the forehearth assembly. Burner blocks, cover blocks, channels, spouts, tubes, plungers and orifice rings are built to meet specified requirements. These CRYSTALITE parts mean better, more efficient production by offering:

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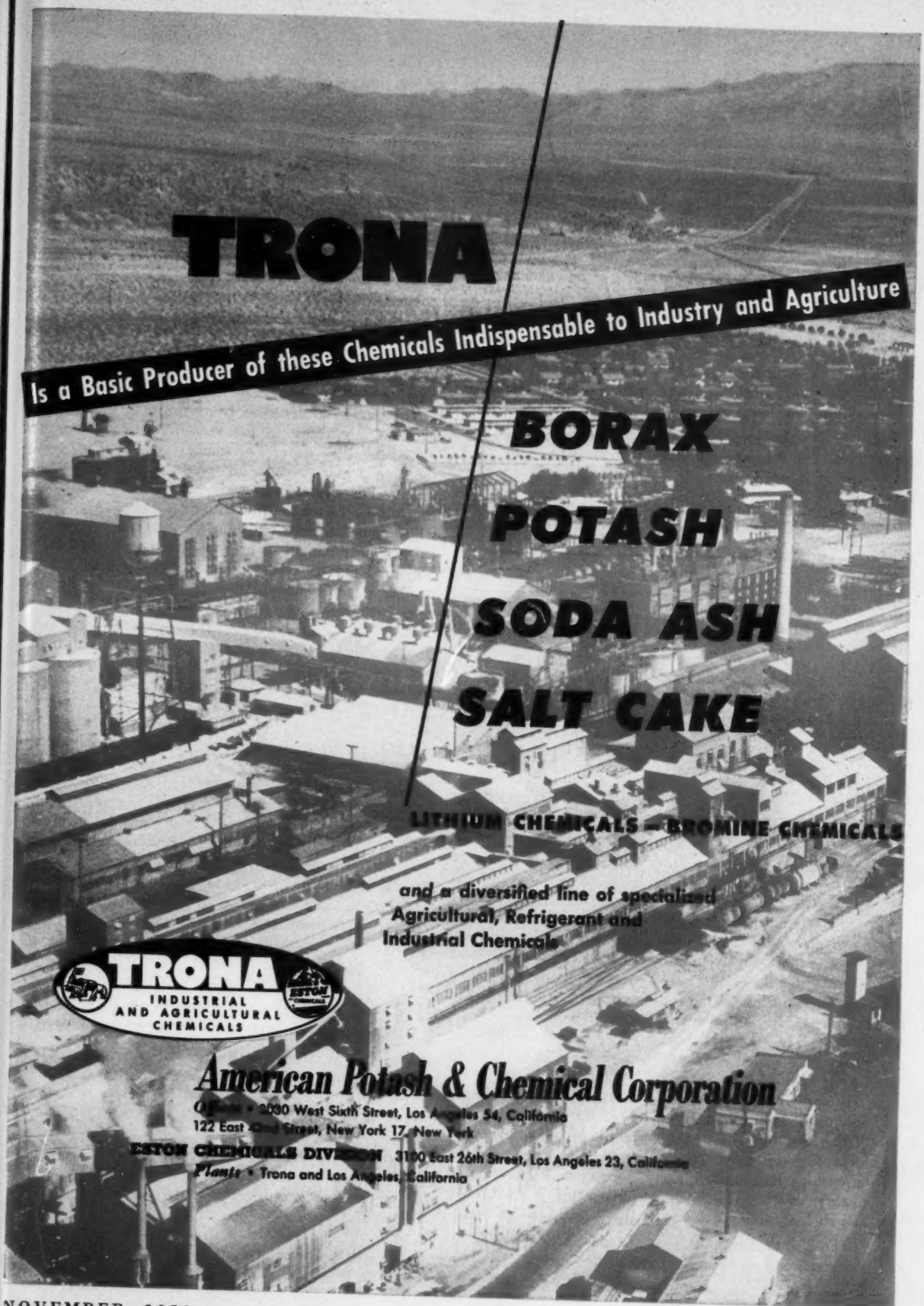
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ELECTRIC ANNEALING . . .

(*Continued from page* 603)

ward yellow. Thus can be determined the nature of the birefringence in a strained glass specimen.

Since, with a gypsum plate of known vibration-direction, it can be determined whether a raising or lowering of the retardation meaning whether addition or subtraction of the color tone takes place, it can accordingly be determined whether compression strain (parallel to (a)), or tension (parallel to (c)), or both, may be present. The degree of retardation can be safely estimated from the color and, from the color and the thickness of the glass, the magnitude of the strain can be calculated according to the following formula:

$$P = \frac{U}{S \cdot K} \qquad K = \frac{\text{Retardation in m}\mu\ (U)}{\text{Strain (P)} \cdot \text{Thickness (S)}}$$

That is, P is in Kg./cm.², U is in millimicrons, and S in cm. For unit strain and unit thickness, the specific retardation* for some glasses is:

Soda-lime,	2.26-2.73
20% Lead oxide glass,	3.11
Borosilicates,	3.22-3.62

A list of interference colors and corresponding retardations (optical-path differences) is given in Table I.

Table I

Retardation	Interference color	Retardation	Interference color
250	— white	565	purple
300	— light yellow	575	violet
350	— bright yellow	600	indigo
430	— orange yellow	665	sky blue
450	— orange	730	greenish blue
500	— red orange	750	green
530	— red ±	800	light green
550	— deep-red	850	yellow-green

Cooling Curves

Through a study of characteristic properties, the most favorable temperature-time curve can be selected for each glass. This curve must be followed in order to attain complete annealing. One difficulty appears in that the curve gives the correct glass temperature, but not the required lehr temperature. In practice, means are present whereby the glass temperature itself can be measured and controlled during the annealing process. Control instruments measure only temperature in the lehr space.

While Fig. 9 shows cooling curves for three different glasses, the actual course of temperatures in a Hartford lehr is shown in Fig. 10.

In applying a cooling curve, attention must be paid not only to the lag of the temperature of the ware behind that of the lehr, but also to the variations in glassware as to form and thickness. The study of these important relationships has, unfortunately, found small attention in research work. The investigations which W. A. Whatmough has carried on may be summarized as follows:

(1) The thinnest portion of the glass article establishes the maximum point on the temperature curve.

(2) The thickest portion of the glass article establishes the time of cooling; that is, the time interval for arriving at the transformation point or, better expressed, for the shortest permissible time and therefore the greatest permissible speed of cooling in reaching that point.

The cooling curves, as well as the time required for the separate phases of cooling, depend upon the particular conditions of plant operation—different for each glasshouse—and also upon the size, shape, weight and thermal properties of the ware treated. The composition of the load also plays a part if different glass varieties are annealed in the same lehr, or in the event that the articles themselves are made of different glasses, as in cased or flashed ware.

Thickness matters greatly. Double thickness requires four times as much cooling time. If the glass article can be cooled from both sides, as with flat glass, speed of cooling can be twice as fast as if the same glass had to be annealed in cylindrical form, losing heat from only the outer surface.

The degree of freedom from strain in glass is quite variable, according to the requirements as to quality placed upon the ware. For example, the standard is high for optical glass because of the concern over refractive index. For commercial ware, such as containers, the controlling factor is prevention of breakage. Glasses which must undergo polishing must be so well annealed as to remove danger of breaking during that process. F. Twyman[5] reports extended study, and concludes that annealing is good enough when less than 5% of breaking stress remains.

If the breaking stress is assumed at 800 Kg./cm.², it may be calculated from the formula already given that the permissible maximum optical path difference per cm. of thickness is

U max. = K.P.S. = $2.85 \cdot 800 \cdot .05 = 114$ mμ cm., while, for a strength of 600 Kg./cm.², the value is 85.5 mμ/cm. Therefore, for commercial ware, a residual strain of 80 to 110 mμ/cm. is permissible. Optical glass should show only 5 to 25 mμ/cm. retardation, corresponding to only 0.2 to 1.0% the breaking stress.

In conclusion, one added factor must be mentioned. Practical glass manufacture often involves allowing ware to cool below its strain point before it reaches the lehr. The first stage of the process must then take care of heating the ware hot enough to relieve all strain, and the cooling curve must be established accordingly.

(*To Be Continued*)

* Usually called "stress-optical coefficient," in the U.S.A.

AMERICAN GLASS REVIEW PURCHASED BY TWO STAFF MEMBERS

J. A. Ebel, Business Manager of the *American Glass Review*, and Donald Doctorow, Editor of *China, Glass and Decorative Accessories*, have purchased controlling interest in the Commoner Publishing Company, publisher of the two magazines.

In addition to the two publications, other periodicals published by the Commoner company are the *Glass Factory Yearbook and Directory* and the *China and Glass Red Book*.

J. R. Hainer, Jr., Editor of the *Review* for the past 12 years, will continue in that capacity under the new management.

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Quality control is a continuous job. It is carried out with modern equipment and painstaking attention to detail in every phase of the production of Nialk chemicals.

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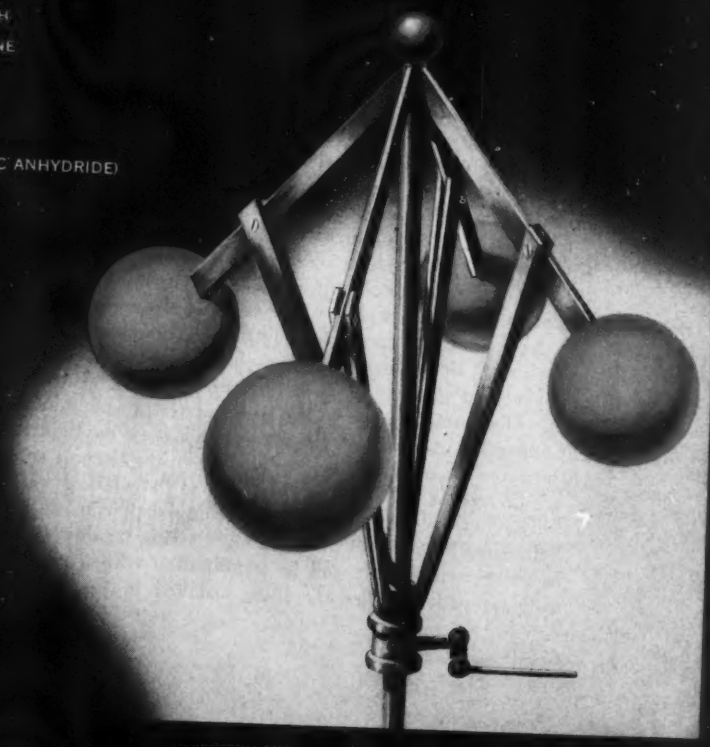


DAYLIGHTING IN THE CLASSROOM OF TOMORROW

Scientists and educators at the University of Michigan have just completed a "classroom of tomorrow" in an effort to create the ideal environment for learning. The classroom provides for complete flexibility necessary in modern schools. It provides maximum freedom in design, decoration and choice of equipment. It gives educators their first glimpse at a long sought goal—homelike atmosphere in a schoolroom.

The "classroom of tomorrow" was made possible by the findings of a 12-year study into the problems of schoolroom daylighting conducted by scientists at the Daylighting Laboratory under the sponsorship of the Kimble Glass Company, subsidiary of Owens-Illinois Glass Company.

Seventy-five per cent of the nation's schoolrooms are operating today with less than the required minimum daylighting standards, according to the estimates of Dr. Robert A. Boyd, Director of Research at the Michigan laboratory. In contrast to these conditions, the "classroom of tomorrow" provides on an average dark day nearly double the recommended minimum of daylight—and much higher quality daylight—in all areas of the room.

As a result, it is possible to introduce decorating colors, equipment design and activities planned which have been impractical until now. It is no longer necessary to confine close detail work to the area nearest the windows. Complete uniformity of glare-free, shadowless daylight in the room makes it as easy for a child in the deepest corner to read as it is for the child next to the window wall.

The new system of daylighting employed consists of light-directing glass block and a clear vision window strip in the exterior south wall in combination with a ribbon of glass panels, called Toplites, installed in the ceiling parallel to the main fenestration and five feet in from the opposite wall. Toplite, a completely new development, is scientifically designed to select the best available daylight while rejecting unwanted heat and glare. It consists of hollow glass units set in prefabricated aluminum grids. Prisms in the glass reject a high percentage of the sun's light and heat when the sun is at high summer altitudes. In winter months, when the sun is lower, the prisms transmit more of the available daylight. All year around it transmits a high percentage of the cool light from the north sky.

L-O-F BOOKLET ON GLASS REINFORCED PLASTIC

The results of extensive tests of the wet strength of chemically treated fiber glass reinforced plastics have been announced in a booklet prepared by the Fiber Glass Division of Libbey-Owens-Ford Glass Company.

According to Don W. Lyon, Manager of the Division's textile sales, the experiments which were conducted by a leading West Coast reinforced plastics fabricator showed that plastic laminates reinforced with L-O-F's Garan treated fiber glass had far greater wet strength. Mr. Lyon said the problem of securing a good bond between the glass cloth and the plastic compound is to get a rapid, thorough wetting of the cloth by the laminating resin.

"A rapid wetting means a firm contact between cloth and plastic," Mr. Lyon explained. "This tighter bond prevents moisture from moving along the glass fibers and into the plastic by capillary action and reduces voids caused by trapped air."

According to the L-O-F booklet, the samples tested were first boiled in water for two hours to approximate 30 days total immersion. Then the laminates were subjected to rigid bending, crushing and pulling tests.

WYANDOTTE APPOINTMENT

N. L. Amend and E. J. Ackerman have been appointed product managers of industrial organic chemicals sales department and antifreeze glycol sales department, respectively, of the Michigan Alkali Division, Wyandotte Chemicals Corporation.

Mr. Amend, a graduate of the Colorado School of Mines, was formerly Assistant Manager of the organic chemicals sales department. Prior to joining Wyandotte, he was in the special products department of the Buffalo Electric Chemical Company.

Mr. Ackerman brings to Wyandotte extensive practical experience in marketing antifreeze. He was previously with Commercial Solvents Corporation as Eastern Regional Sales Manager of their specialty department.

FORMER MORGAN CONSTRUCTION EXECUTIVE DIES

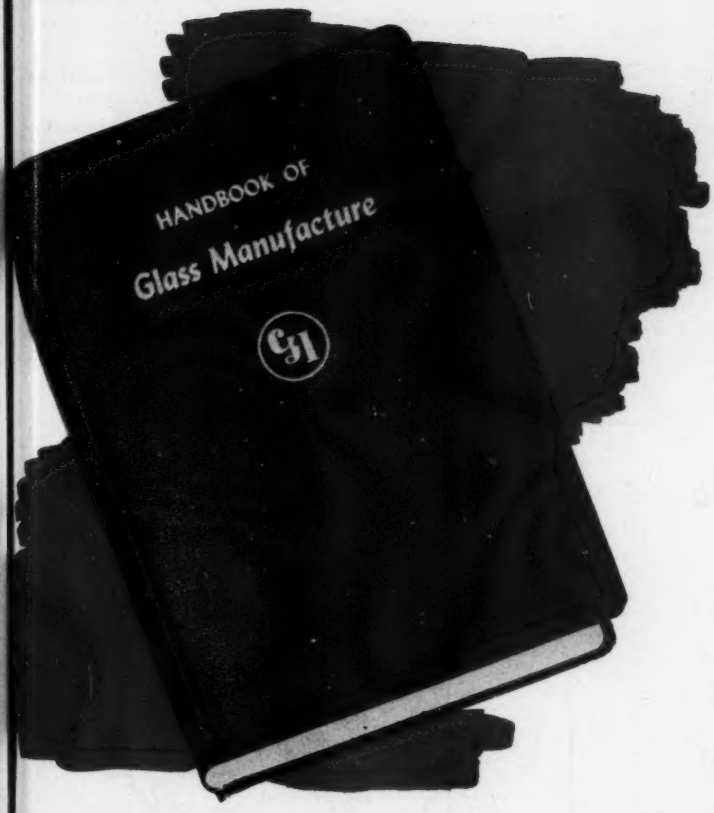
John W. Sheperdson, 74, who retired as Executive Vice President of Morgan Construction Company in January 1952, died at his home in Worcester.

Mr. Sheperdson served with the company since January 1916 and in 1926 was elected to the Board of Directors. In 1929 he became Vice President and has served in a consulting capacity to the directors after his retirement.

He is survived by two sons, Robert W. and John P.; a brother, William; and four grandchildren.

It's *new*

and it's *different*



IT'S NEW because twelve years have passed since the first handbook for glass manufacturers was published and so much has taken place in the intervening years in technological and engineering development.

IT'S DIFFERENT because it is the only single volume where so much pertaining to all phases of glass manufacture will be found.

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DOUBLE-TOUGH PIPING EXHIBIT

Shown above is the interior of Corning Glass Works' new traveling van, equipped and designed to exhibit corrosion-resisting Pyrex Brand Double-Tough Piping. The exhibit includes a field fabrication demonstration and a cascade cooler, piping layout and bubble cap column, all in actual operation.

Also displayed are a jacketed heat exchanger, a packed fractionating column, all available pipe sizes, standard and special fittings and components, and methods of adapting glass to other piping materials.

Viewing the van's interior are, left to right, Corning executives F. F. Fleischman, Jr., R. H. Mariner and Russell Brittingham.

AMERICAN POTASH RESEARCH EXPANSION

A comprehensive policy of research development and expansion has been announced by Peter Colefax, President of American Potash & Chemical Corporation. The new program is based on the upgrading of Trona products into fine chemicals for use by agriculture and industry.

Mr. Colefax stated that the new policy calls for focusing attention on the boron, lithium and bromine fields, in which it is felt that the company has a head start for the exploring the market applications for them.

• Carmine J. Venuto recently joined Foote Mineral Company's Research and Development Department as a mineralogist. Mr. Venuto received his M.A. degree at Harvard in 1951 and was with New Jersey Zinc Company before joining Foote.

Correction: In connection with the published work by Guy Mayer and Jules Gueron, which was translated in the March 1953 issue of THE GLASS INDUSTRY, information has been received concerning a factual error which, in the translation, appears on Page 131, bottom of column one.

The statement there that Si atoms surrounded by four 0 are closer to two of them, namely at 1.63 Å as compared with 2.18 Å for the others, is erroneous, as it was taken from the incorrect listing in Davey's "Study of Crystal Structure and Its Applications," McGraw-Hill 1934, p. 146. Correct modern data can be found in Wykoff's "Crystal Structure."

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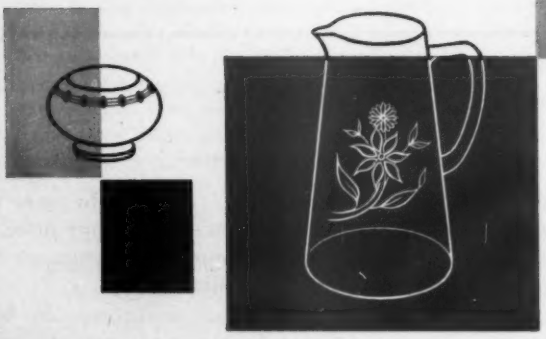

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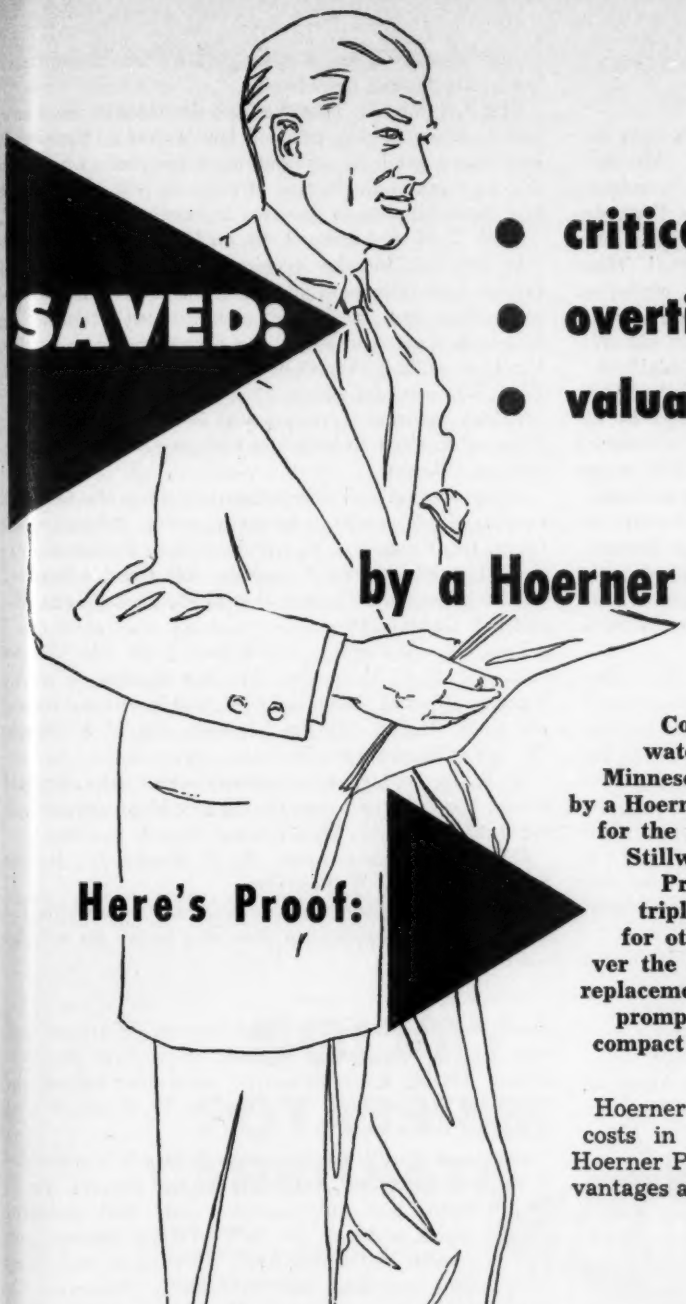

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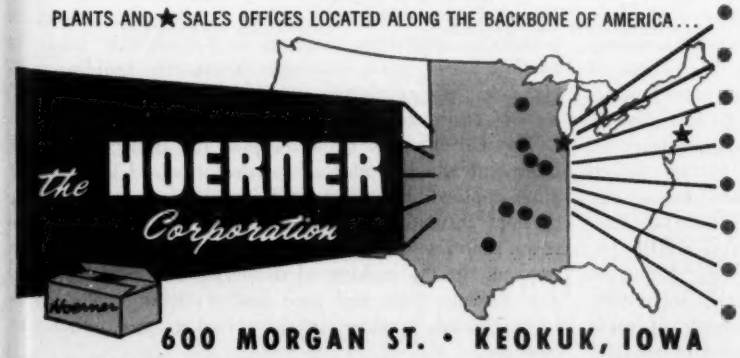

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GLASS DIVISION MEETING . . .

(*Continued from page* 604)

first began telling about network formers, I thought they meant glass fibers, but I gradually learned differently. And as for "linkage," the word always sets me wondering how long our oldest lehr belt will last. Here I've spent my life trying to get the gases all out of my glass, and now I hear that the stuff is almost all oxygen! Those electron-microscope shadows of glass fibers made 'em look like pieces of hemp rope, but I got eye-strain trying to see on them what those fellows tried to point out. No, glass isn't what it used to be—maybe it never was!"

The business session was brief. Reports on the Standard Glass Samples indicated that data obtained by the half-dozen cooperating laboratories will soon be collected and prepared for distribution, so that the standard glasses will serve a real purpose in checking analyses and measurements of physical properties. Dr. F. V. Tooley, the efficient Secretary, reported that the Rules of the Division, after minor editorial changes, would be published in the *Bulletin of the American Ceramic Society* early next year. The Fall Meeting for 1954 will be held at Mellon Institute, Pittsburgh, October 8 and 9.

Older members of the Division will recall that a feature of the Fall Meeting, 1938, was a visit to sites of colonial glass factories, under the guidance of an amateur archaeologist. In recognition of that early work, the following resolution was offered by D. E. Sharp, seconded by F. C. Flint, and voted:

"Whereas: Before the researches, explorations and excavations by Dr. W. J. Sparks, the existence of glass factories at Jamestown Colony remained only an historical tradition unsupported to any extent by tangible evidence, and

"Whereas: These researches were carried on over a period of many years at great personal effort and sacrifice by Dr. Sparks, therefore,

"Be it Resolved: That the Glass Division of the American Ceramic Society offer to Dr. Walter J. Sparks an illuminated scroll in recognition of his pioneer work in the discovery and collection of artifacts pertaining to the first glass factories in America at Jamestown, Virginia".

A. S. T. M. Committee C-14, on Glass and Glass Products, met on Thursday evening with L. H. Ghering of Preston Laboratories in the chair. Interim reports of subcommittees were read, and returns from balloting on Standards were reported by the Secretary, F. V. Tooley. Mr. L. C. Gilbert, Assistant Technical Secretary of A. S. T. M., was a helpful visitor.

Friday morning recreation was in charge of Hugh L. Kline, of Corhart Refractories Company. He reports results as follows:

In the Annual Golf Tournament played on the Oak Hill Country Club course, winners were as follows: *Low Gross*, Jim Poole, 86; W. Gilluly, 87; A. R. Cooper, 91; Keith Conrad, 92; Ed Humphrey, 92; Charles Bradley, 93; Dick Hummel, 93; Ken Henry, 94; Fred Pinotti, 94; and Bob Dowling, 96.

Low Net, Al Lasday, 71; Walter Ford, 74; Charles Cala, 75; E. C. Ostrander, 75; Jim Hackett, 77; Guy Rindone, 77; Jim Coleman, 78; R. Coble, 78; Bob Curts, 78; R. W. Holler, 78; Jim Kindelan, 78; N. E. Wendt, 78; and O'Mara White, 78.

In bridge and canasta, winners were: Mrs. Donald Sharp, Mrs. S. R. Scholes, Mrs. Henry Moore, Mrs. C. E. Leberknight, Mrs. F. W. Glaze and Mrs. T. G. Pett.

Door prize winners were: W. H. Blenko, Jr., Jerome S. Osmalor and L. W. Peterson.

The Committee and winners were most appreciative of the kindness of suppliers in providing prizes for all contest winners.

5000 YEARS OLD — WITH A BRIGHT FUTURE

Expanding opportunities for glass to serve the American economy are seen by scientists at Battelle Institute, Columbus, Ohio. Writing in the current issue of the Cleveland Federal Reserve Bank's *Monthly Business Review*, President Clyde Williams and his associates sum up their views this way:

"During the past 50 years, the fundamental process for making glass and the techniques for fabricating finished glass products have been studied in microscopic detail. A better understanding of the physical and mechanical properties of glass and the chemistry of glassmaking has been achieved. The application of this knowledge has brought outstanding growth in the variety of glass products made, in the development of mass-production methods, and, hence, in glass usage. In this growth, we see indications for new horizons of accomplishment.

"From the almost exclusive domain of the skilled craftsman, glassmaking has been built into one of our most important, most highly mechanized industries. Production in a recent year was valued at around $1.5 billion, or about one-third of the nation's total output of ceramic products. Although there has been increasing competition with other materials, the number of glass containers made each year is now about two-and-one-half times the prewar annual average. In the last two decades, plate glass has shown a tenfold increase in annual volume, and the production of sheet or window glass has tripled. During the same period, glass fiber output, the infant of the industry, has risen to 75 thousand tons annually."

Continued growth in glass usage is largely a reflection of the ever-expanding versatility of the material itself. Mr. Williams and his associates state that ordinary glasses, which make up the bulk of glass tonnage, are used for such well-known items as window and plate glass, bottle containers and light bulbs. However, six other major types are listed. These are used for hundreds of specialized applications ranging from chemical pipelines, insulating material and electronic tubes to camera lenses, giant telescopes, decorative building panels, glass burner plates, and table-, crystal-, laboratory-, signal-, and oven ware.

The development of techniques for fabricating glass fiber and allied products has revolutionized thinking on glass applications. Glass fiber is now used primarily for thermal insulation, sound control, air filters and pipe wrap. However, many growing and potential markets are seen in the making of draperies and curtains, window screens, boat and auto bodies, fishing rods, cable covers, twine, washing machine baskets and upholstery cushions.

Particular attention is drawn to great improvements in

fabrication and finishing equipment. Light bulbs, formerly blown by hand, are being produced at rates of around 60,000 per hour. Glass can be fabricated into fibers thinner than the human hair and into 1600-pound windows for supersonic wind tunnels. Plate glass rolling speeds of 80 inches to 90 inches per minute, in common practice ten years ago, are climbing toward 300 inches per minute, and the limit is not yet in sight. Strips of glass eight feet wide and up to 900 feet long can be ground and polished simultaneously on both surfaces. The development of techniques for coloring glass in thousands of different color tones, sealing metals to glass and for metallizing glassware has been indispensable to expanded usage for certain applications.

"The country's total consumption of glass by 1975 is expected to be double that of 1950, according to a prediction of the President's Materials Policy Commission. As in the past, a large part of the growth will result naturally from expansion of the nation's economy. Upward trends in the amount of glass used for a given application, as, for example, automobile windows, will continue to be an important factor. Increasing usage of relatively new products such as glass fiber and foam glass may be expected in spite of their entrance into 'unconventional' fields of application where competition with other materials is keen. Perhaps most important, however, will be the genius of the glass industry itself, whose unquenchable thirst for more knowledge about the properties of glass and the techniques of glassmaking continues to extend the range of applications for glass in industry, science and the home."

CONFERENCE PAPER SUMMARIES . . .

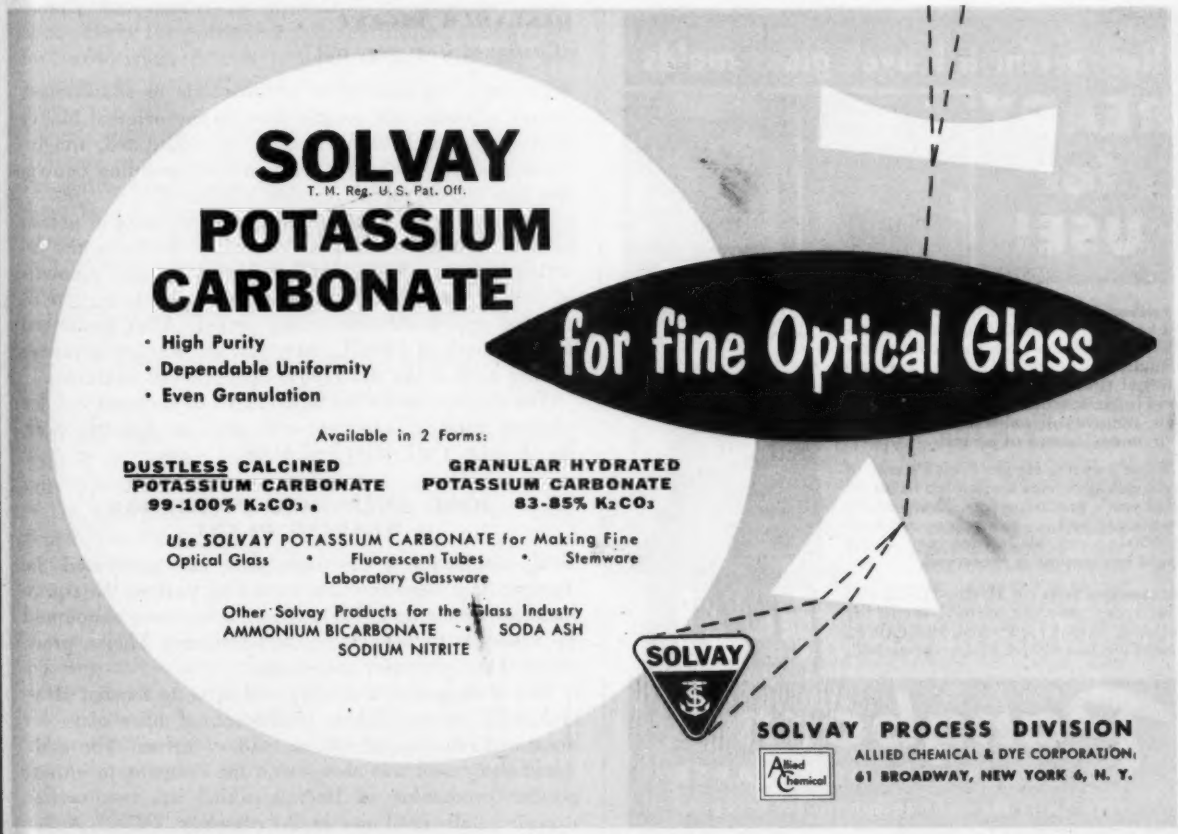
(*Continued from page* 608)

coolers are also a must. In the case of the electric power supply, good practice provides from 20 to 30% more sub-station capacity than the design requirements of the plant.

With the plant designed and ready to operate, selection of proper personnel should not be forgotten. A great many plants today are using help, especially in furnace and forming operations, that are from the "old school." While many of these "old school" graduates may have been skilled in hand shop operation, they may not be the easiest to train for automatic operation.

Having outlined the fundamental factors affecting design for present operations, consider what the future should hold in the further development of glass container productive equipment. The general goal is the fully automatic glass container machine. There is no reason why it cannot be competitive with the can machine and the paper bottle machine, both in space requirements and in ability of produce with minimum of supervision.

• Announcement has been made of the appointment of Ray Beckley, formerly District Sales Manager of the Insulux Products Division of Kimble Glass Company, as Manager of Industrial Sales and head of product development at Thompson Glass & Paint Company. Also announced is the appointment of Robert George, formerly Vice President and Director of Sales of Glass Products, Inc., to manage the company's window department.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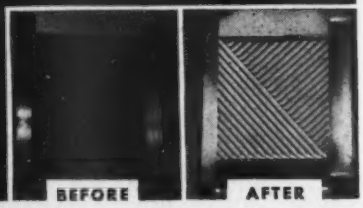
Pennsalt Chemicals

Hydro-Finish leaves glass molds READY for USE!

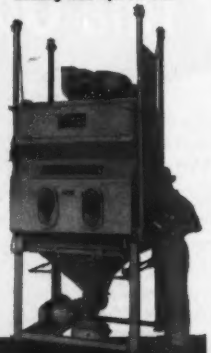


Complicated molds are easily cleaned and left *ready for use* with Pangborn Hydro-Finish! Hand cleaning and polishing is virtually eliminated! And you save additional time and labor because a Hydro-Finish machine, operated by one man, removes discoloration and scale in *minutes* instead of hours!

What's more, Hydro-Finish's use of fine-mesh abrasives suspended in liquid gives you a precision job. Sharp edges are maintained . . . tolerances are held to .0001 . . . molds last longer . . . precision equipment is protected.

Get complete facts on Hydro-Finish and how it can save *you* money! Write for Bulletin 1400-A to: PANGBORN CORP., 3400 Pangborn Blvd., Hagerstown, Md.

Actual untouched photos of mold before and after cleaning with Hydro-Finish



Pangborn
BLAST CLEANS CHEAPER
with the right equipment for every job

NATIONAL SAFETY CONGRESS . . .

(*Continued from page* 614)

constant sound level of 50 decibels or less prevails. Technicians to operate the audiometer, used for testing the employee's hearing, are trained by the medical department.

Each man's previous employment history is gone over with a view to bringing out jobs he has handled that were noisy in character. He is asked if he worked as a milling machine operator, a boiler maker's helper, etc., and his opinion is sought as to whether he thought it was a noisy job. The man's military experience is important, he being asked what service he was in, what he did, etc. Other questions include: Do you hear over the phone? In a theatre? Do you use, or have you ever used ear protection devices? Often or seldom? Was it cotton, or a wad of chewing gum?

Answering a question from the floor, Mr. Scholtz said the company has no data as yet showing improvement in worker efficiency resulting from noise abatement. If a firm feels incompetent to make its own noise survey at the start, he suggested, there are outside services available to perform this task. Insurance carriers, or private consultants can be called on, he also stated.

Allis-Chalmers, Mr. Scholtz concluded, has just barely started its noise abatement program and much still has to be worked out. Industry can expect much help from the Industrial Hygiene Foundation which, he said, is starting studies of what has been done in the industrial world to abate noise. This, he hoped, will supply answers, now lacking, to many phases of the subject.

RESEARCH DIGEST . . .

(*Continued from page* 621)

boric oxide replaces silica in silica-soda or silica-potash binary mixtures are greater than in the original binary mixtures. When the boric oxide is substituted, weight-for-weight, for soda or potash in corresponding equivalent amount, the rate of reaction is reduced.

The addition of small amounts of either soda or potash to a silica-boric oxide binary mixture increases the reaction rate considerably. The addition of small amounts of lime to a silica-boric oxide mixture retards the rate of reaction appreciably for a long period. After prolonged firing periods at 1400°C., however, the reaction proceeds farther than in the silica-boric oxide binary mixtures.

The various oxides can be arranged in decreasing order of their rates of reaction with silica as follows: K_2O, Na_2O, B_2O_3, CaO, MgO and Al_2O_3.

HESS, GOLDSMITH PURCHASES WEAVING PLANT

Hess, Goldsmith & Company, Inc., has purchased the Taylor, Pa., weaving plant, including part of the equipment, of Goodman & Theise, Inc., it has been announced by James A. Goldsmith, Jr., and Benjamin Theise, presidents of the respective companies.

The newly-acquired facility will serve to expand Hess, Goldsmith's broad fabric production of fiber glass for decorative and industrial use and of nylon. The additional equipment will also permit the company to initiate regular production of Dacron, which has been woven experimentally until now by the company.

CORNING APPOINTMENTS

Three top appointments in the Corning Glass Works Traffic Department have been announced by John E. Merz, Jr., the company's Director of Transportation. John D. Mitchell has been made Traffic Manager, and R. William Cooper and Joseph L. Bula were named Assistant Traffic Managers.

Mr. Mitchell, who has been Assistant Traffic Manager since 1951 when he joined Corning, directed traffic operations in various Chicago firms for 26 years.

Mr. Cooper has been associated with traffic work since 1918, joining Corning's Leaside, Canada, plant in 1947. He transferred to the Traffic Department in Corning six years ago.

Mr. Bula has been general traffic and rate clerk with Corning's Traffic Department since 1951, having prepared for traffic work with study at the New York Traffic Management Institute.

BOOK REVIEWS

Protective Atmospheres

By A. G. Hotchkiss and H. M. Webber

This new book, written especially for plant and process engineers, provides a concise survey of the properties, applications, generation methods and results of atmospheric gases. Based on a series of articles that first appeared in the *General Electric Review*, the volume adds new material, as well as coordinating previously scattered information. This over-all picture includes discussions of basic chemical reactions of gases used for furnace atmospheres, atmospheres for preventing or reducing oxides, atmospheres for preventing decarburization, atmospheres for carburizing, carbon restoration and nitriding, and instruments for analyzing, controlling and measuring gases.

Particularly important are the chapters headed "Distribution and Handling of Gases" and "Remedies for Protective Atmosphere Ailments." In the latter, the authors have included tests for determining the types and sources of trouble, and the effects of gases on heating unit materials, refractories, thermocouples, personnel and metals.

Published by John Wiley & Sons, 341 pages, $7.00.

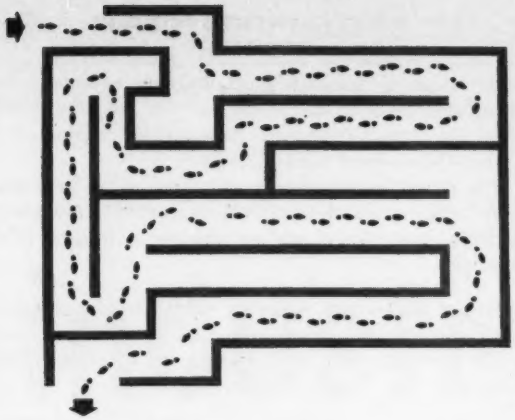
Foams: Theory and Industrial Application

By J. J. Bikerman

This new book, written by J. J. Bikerman in collaboration with R. B. Booth, J. M. Perri and C. C. Currie, is the only complete treatise on the subject of foams.

The first section of the book, comprising about three-fourths of the material, is devoted to the chemical and physical properties of foams. Such phenomena as foam formation and structure, foam drainage and the mechanical, optical and electrical properties of foams are discussed in full detail with appropriate emphasis on physical chemical concepts. Subsequent chapters describe many important applications of foams in such fields as fire protection and froth or ore flotation. The final chapter offers information on the chemical destruction of foams important in petroleum and lubrication technology.

Published by Reinhold Publishing Corporation, 345 pages, $10.00.



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L-O-F LAUNCHES MIRROR CAMPAIGN

Mirrors for the home will get the most aggressive merchandising push in the history of the business this fall from an across-the-board promotional campaign by Libbey-Owens-Ford Glass Company.

The campaign, which will be geared to the interests of manufacturers and their customers, embraces advertising, publicity and point-of-sale merchandising in a correlated package.

• Robert W. Garrett, formerly Vice President of Garrett and Company, has joined the Thatcher Glass Manufacturing Company. He is a graduate of Virginia Military Institute.

HARBISON-WALKER APPOINTMENT

Leo L. Gill has been appointed Manager of the Technical Sales Department of Harbison-Walker Refractories Company. He will maintain headquarters in the company's home offices in Pittsburgh and will report to W. F. Rochow, Vice President.

Since 1923 Mr. Gill has been employed in Harbison-Walker's Engineering and Technical Sales Departments. He is recognized in the refractories industry for a number of inventions, including refractory checker shapes for furnace regenerators and special brick shape designs for furnaces of various types. Mr. Gill, who attended the University of Notre Dame, is the author or co-author of approximately a dozen papers published in technical magazines.

A. C. S. PITTSBURGH SECTION MEETING

At the November 10 "P.C.A. and Penn State" night held by the Pittsburgh Section of the American Ceramic Society, following the introduction of the new officers of the Pennsylvania Ceramics Association and Dr. E. C. Henry's annual report on ceramics at Penn State College, W. L. Kenagy highlighted the meeting with his talk on "Abrasives, Tool of Industry."

A ceramic engineering graduate from Iowa State College with 20 years experience in the abrasives field, Mr. Kenagy is Factory Manager of the Simonds Abrasive Company.

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